Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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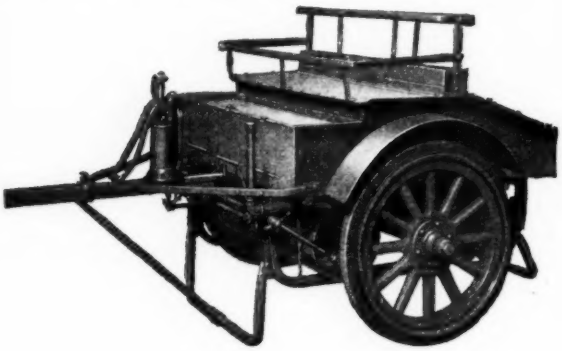

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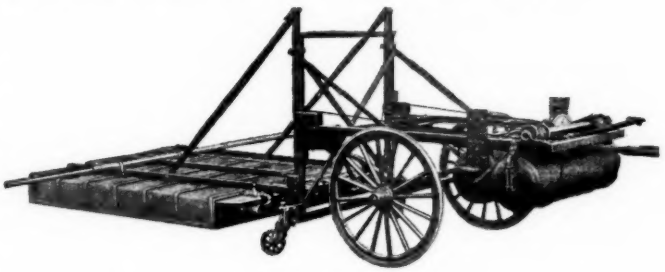

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EDITORIALS

THE ENGINEER AND CIVIL SERVICE

It is sometimes suggested that the employment conditions of engineers would be improved if all engineers in the public service were put under civil service regulations. An inquiry as to the wisdom of this procedure develops a wide difference of opinion among those who are best able to pass judgment on the proposal. Some are very strongly in favor of it and others are as strongly opposed. Some favor civil service only for the chief and others only for the subordinates. Even those of similar experience with civil service hold quite dissimilar views as to its efficacy. All of this confuses counsel and gives the detached observer pause.

All argue that civil service has its advantages as well as its disadvantages; the difference of opinion arises as to which outweighs the other. It is profitable to consider some of the pros and cons as advanced by distinguished engineers in their correspondence with the editor.

The principal argument favoring the placing of engineers in the public service under civil service is that it protects them against the spoils politician and thereby lengthens their tenure of office with corresponding opportunities for advancement in the service. Some deny this advantage, saying that where there is a will to remove an engineer a way can be found even if he has the protection of civil service. So widely do observers differ on this point that one is forced to conclude that what works well in one city does not work as well in some other cities. Where those in control of the situation are friendly to civil service and want it to work well it can and usually does work well, but where they want to beat it they can do so, although it is an obstacle to unrestrained favoritism. Where an applicant for a position must prove himself well fitted for it in a competitive examination before a competent and unbiased board, tenure of office becomes more secure and the appointment of personal or political favorites is reduced to a minimum.

The principal argument against civil service is that it is the last refuge of mediocrity. It is argued, also, that those who enjoy this form of protection pay rather dearly for it in lowered salaries, and that when men feel secure they do not function at their best and so are not worthy of greater compensation.

There is, of course, nothing novel in the suggestion as civil service is very far from a new idea. There has been long experience with it in some cities. It is worth while to find out why it works so well in some cities and so poorly in others. It is worth while to consider, also, if its apparent advantages are real and if these advantages can be secured equally well or better in some other way. Readers who hold opinions on the subject are invited to write them out for publication.

SIDELINES FOR THE ENGINEER IN PUBLIC SERVICE

Not long ago the editor suggested that engineers in public service might do well to take up sidelines to increase their income. This has been done frequently, of course, and the thought back of the suggestion was that it might well be done more generally. The idea was advanced in these words: "Every engineer has some spare time, some reserve energy and much latent ability which if joined to the other fellow's money, should provide the engineer an outside income. Some, but probably few, engineers have looked around a bit for this outside opportunity. If the engineer can earn something, and he may earn much, on the side, he will become more independent and more assertive of his rights as an engineer; his earnings from engineering will increase if he doesn't have to be too thankful for small favors. Engineers in public service have exceptional opportunities to achieve a degree of independence of engineering."

This suggestion has produced some interesting reactions from engineers in public service. The opinions expressed are by no means all favorable to the proposal. In fact, the weight of opinion is against it on theoretical grounds, although some modify their objections in view of considerations of practicality associated with

the means of subsistence. Some of the views advanced are here presented in brief.

One engineer admits the difficulty of reaching a settled conviction on the subject. Sometimes he feels that it is utterly wrong for a public employe to do outside work, but realizes that some of them must in order to make both ends meet. Another does not advocate the practice unless it is in connection with the promotion and advancement of his position in his profession. This engineer argues that sidelines keep the engineer satisfied with small salaries. Another argues that outside work is bound to broaden the engineer and make him of more value in his regular occupation. He says, also: "I like the suggestion that every engineer can readily find opportunities in which he can mix his engineering skill with the financial backing of the financier or business man to mutual advantage. In such instances the engineer's function is that of a promoter, at least that of investigator or planner. In this connection, however, we are almost certain to encounter opposition from engineers and employes who feel that an engineer employed on a fixed salary owes all his time and energy to his main job. This argument does have merit, though I am rather inclined to think that the points mentioned are of greater practical importance."

Another engineer, a highly respected veteran, points to the danger in sidelines, whether commercial or professional. It is difficult to do full justice to two unrelated lines, and where the sideline is professional it may become embarrassing or even compromising. He approves the idea to this extent: "There is one line of work which may be considered a sideline that is appropriate for an engineer in public service, and that is work as a consultant for the benefit of other governmental bodies who have work to do similar to his own. Such consulting work is not only profitable commercially but is beneficial to the agency that consults him and indirectly is of real value to the governmental body that regularly employes him. Such work really broadens his experience and his knowledge, and does not in any way interfere with real service to his regular employer." This seems a wholesome philosophy, yet even this does not leave everybody happy for the consulting engineer in private practice makes strenuous objection to it.

Another successful engineer in municipal service says: "I do not think it possible for a progressive engineer to avoid sidelines and in many instances this has been the only possible excuse for a man remaining in the public service. I think he should be encouraged to the limit, and I think there is no danger of excessive development as municipal administrations are as a rule jealous of such employes' time, and it is impossible to develop a sideline to excess."

One city engineer disposes of the suggestion with some finality in these words: "Our charter says that the city engineer shall devote his entire time to city business. Up to date I have found this requirement of the charter entirely unnecessary since I have had utterly no time to devote to any but city business. The strain on an engineer in public office is so great and the demands that the progress of the profession makes on his time are so considerable that both time and energy are lacking for anything beyond his work."

Another public service engineer says: "I do not believe that encouragement of sidelines is advisable. The best commercial organizations discourage sidelines for their employes upon the principle that a man should put all he has into his job, and that if his job does not demand all that he has he better get a new job."

One city engineer tells how this problem was solved in his city. At one time engineers in his department were in the habit of doing outside work, such as surveying for additions, for lots, grading jobs, etc. They derived considerable income from this work done outside of office hours. They generally used city equipment and there was always more or less criticism from outsiders, from other engineers, and some from the city council. At length the city engineer wrote a letter to the council asking for an increase in all salaries, showing what the members of the department were doing and what they were receiving for their outside work. He went into details on all the activities, showed what percentage of the cost of the work would be charged by practicing engineers and how much less the city was paying. This was good enough argument to produce results in the form of increased salaries. At the same time it was agreed not to do any more outside work. This plan has now been in effect for three years and is giving satisfaction. Perhaps the sidelines in this case worked out ultimately to the good of all parties and at this happy turn in the discussion we shall alight as gracefully as may be.

WRAPPING CONCRETE BRIDGE ABUTMENTS IN AN ASPHALT BLANKET

By J. F. Seiler, Engineer of Bridges, Wyoming State Highway Department, Cheyenne, Wyoming.

In recent years, and as a result of extensive highway development and construction, more and more study has been given to many of the minute details in connection with the design of roads and pavements, with a view to overcoming all of the defects which sooner or later appear as a result of non-attention to these factors. For example, studies of capillary action of water in various subsoils as affecting the bearing power of the foundation of the road, have been made, and there is no doubt but that even such a seemingly minute detail in the design of a road must be taken into account and properly provided for, if the best results are to be had.

In a general way, in bridge-work, the bearing power of the soil on which the structure must rest has been pretty well determined, and since, as a rule, foundations for bridges generally extend underneath the water table, such questions as noted above in connection with road design do not present themselves for solution to the bridge engineer. There are, however, many other problems equally as vexations, which affect that part of the structure hidden from sight and which, in turn, is the most important part of the structure. Reference is made to agencies which in one way or another attack and eventually destroy the foundations of bridges.

For many years it has been a matter of common knowledge that timber structures in sea-water are subject to the attack of marine borers, and treated timber has been largely used in an attempt to overcome their attacks, and more recently it has been discovered that certain mollusks penetrate even concrete coated piles, and tend to destroy such a type of protective coating. In many localities the soil in which bridge foundations are constructed is saturated with certain chemical salts which act upon concrete and often result in a complete disintegration of this most important part of the bridge structure. Most common of these salts is alkali, which occurs widely distributed throughout the Western States.

Such a condition was found to exist along the Powder River in Wyoming about 40 miles west of Casper, where it was proposed to construct a 100-ft. concrete bridge to carry the Yellowstone Highway over this stream. Near the site of the proposed structure, the C. B. & Q. Railroad crosses the same stream with a large concrete culvert carrying a heavy earth fill, and at various times the maintenance on this structure has amounted to a case of practically reconstructing the portions of this structure below low water elevation.

In view of these conditions, it became necessary to devise some means of protecting the substructure of the proposed bridge from the disintegrating effects of this strong alkali saturated soil. After much study the following plan was adopted:

A sub-foundation of 6 ins. of concrete mixed in the proportions 1:3:6, or known as Class "C" Concrete was laid down in the dry and allowed to take a firm set. Upon this dry sub-foundation a thorough swabbing of hot asphalt was put down, immediately after which a heavy burlap was laid, followed with another swabbing, and two more layers of burlap, each thoroughly swabbed with hot asphalt. The main footing of the abutment was then poured, followed by the walls and counterforts. The burlap blankets were cut large enough to permit of them being wrapped entirely around the footing and extending well up on the walls of the abutment and the entire surface beneath them thoroughly swabbed. From the upper extremities of the blanket, the walls and counterforts were painted with asphaltic paint up to a point well above low water. Both abutments and the central pier were similarly treated. Great care was taken in completely filling any spaces between the upper edges of the blanket and the concrete so as to obtain perfect adherence and thus prevent any spaces through which the alkali charged water might seep into the concrete.

The waterproof painting is generously thick and of excellent quality. It is believed that successful results will be obtained by this method of protection, the cost of which was very small indeed when taking into consideration the possibility of the entire loss of the foundations within perhaps less than ten years under other circumstances.

The Wyoming State Highway Department does not know of any other cases in which similar measures have been taken to protect concrete foundations, or in fact any measures at all, except ordinary waterproofing, which in this particu-

lar case was not considered sufficient. The department will therefore watch with a good deal of interest in the years to come, the effectiveness of this method of protecting underground concrete against disintegration. Figures covering the exact cost of this work are not just now available, as the contractors were paid for it under the item of concrete, but roughly speaking the cost was approximately 2⅓ percent of the cost of the entire bridge.

The bridge structure, consisting of two 50-ft. reinforced concrete girder spans on 14-ft. abutments and pier, together with the protection, was designed by the writer, and the work carried out under his general supervision. C. H. Bowman, District Engineer of the Department, and located at Casper, was in general charge of the work, with J. S. Manion, Resident Engineer, in direct charge. Contractors were the Security Bridge Company of Billings, Montana, who executed all the work to the complete satisfaction of the department.

CONCLUSIONS REACHED AT PENNSYLVANIA CONFERENCE OF REPRESENTATIVES OF 25 STATE HIGHWAY DEPARTMENTS

Selection of road types with some idea of the use to which the road will be put, removal of State Highway departments from politics, a tax on gasoline so road users will pay for road construction and maintenance in direct ratio to the extent they use roads; a traffic survey in each state; uniform motor legislation, and elimination of all grade crossings, are recommended to the American people in the report of the Conclusions Committee named by the highway conference recently called by Governor Gifford Pinchot, of Pennsylvania.

Road officials from 25 states met in Harrisburg and for two days discussed highway problems. To summarize the conclusions of the conference, a committee was named, of which Thomas H. MacDonald of Washington, chief of the Federal Bureau of Roads, was chairman. Other members were Col. Frederick Stuart Greene, highway commissioner of New York; Chief Engineer A. W. Dean of the Massachusetts Highway commission; Frank Page, chairman, North Carolina Highway commission; Paul D. Sargent, chief engineer, Maine; Clifford Older, chief engineer, Illinois; H. G. Shirley, chairman of the Virginia Highway commission; Charles J. Bennett, commissioner, Connecticut; and William H. Connell, assistant state highway commissioner of Pennsylvania.

The report of the conclusions, committee is as follows:

Administration

The construction, maintenance, financing, and operation of highways is becoming more and more a question of nationwide transportation and less one of neighborhood convenience. There are two general phases to every problem coming before a state highway department for solution—the business and the technical. A majority of the states have recognized this fact by providing for either engineer commissioners or technically trained engineer executives. We believe this principle is sound fundamentally and urge the state authorities, both executive and legislative, to provide at all times strong engineering control in the administrative and executive work of their state highway departments and engineering supervision of the construction, maintenance and operation of the highway systems.

To this end we urge that these departments be removed from political influences, and that continuity of service be preserved for a sufficient period to insure stabilized policies. In no other way is it possible to safeguard and protect the interests of the citizen who is paying for the roads.

State highway departments, with their knowledge of the geography and topography of the states, should determine without legislative or other interference, what roads or systems of roads should be constructed and maintained with state funds and should not be governed by legislation as to types and cost of construction.

Finance

The highway departments should be operated under a budget system.

The cost of building and maintaining an adequate system of highways should be distributed equitably among the sources of highway revenue in proportion to the benefits derived from the improvement.

The permanent features of original construction of highways should be financed on the "pay as you go" plan or from the

proceeds of serial bonds, according to the stage of development of the highway system now existing in the several states.

The policy of requiring the user of the roads to pay for the service received through a license and gasoline tax is a sound one, and all revenues from such sources should be applied primarily to the maintenance and reconstruction of highways.

Construction

Owing to variations in climate, soil, traffic conditions and available materials, no one standard type of pavement is practical for the country or even for a state.

Granite block, brick and bituminous tops on a concrete foundation, and a concrete pavement may be termed as construction of the first class; the so-called flexible types of pavements may be termed as construction of the second class; and gravel, sand and clay or other top soil may be termed as construction of the third class.

The progressive method of construction, whereby the grading, structures and drainage are first completed and the hard surface pavement laid later, is both practical and at times the most advantageous method of highway construction.

Maintenance

Unless adequate maintenance is provided for, initial construction of highways should not be undertaken at all.

The same engineer who builds the road should be held responsible for its upkeep.

Traffic

Each state highway department should establish a traffic bureau to make a highway transport survey in all its phases to determine present, and forecast future, traffic conditions to assist in the selection of the economic road construction.

Efforts should be made, in co-operation with motor vehicle officials, to establish as soon as possible, uniform motor vehicle laws and regulations, so that the user of the road may travel under uniform laws wherever he goes.

It is highly desirable that a uniform law be enacted by the states of the union regulating the dimensions of motor driven vehicles and the wheel load of such vehicles.

An effort should be made to provide proper standard devices for the protection of the road user and the prevention of accidents, and no person should be allowed to operate a motor-driven vehicle upon a public highway until such driver has been examined and a license showing competency has been granted.

We believe in the installation of simple, easily followed direction signs.

A more determined effort should be made promptly to eliminate all grade crossings.

Realizing the grave responsibility resting upon the officials charged with the administration of the highways for the safety of the public, we earnestly appeal to the people at large to aid in making these conclusions effective.

ARE CITY MANAGERS ATTEMPTING TOO MUCH?

By John F. Druar, of Druar & Milinowski, Consulting Engineers, Globe Bldg., St. Paul, Minn.

A number of years ago, the writer became enthusiastic over the scheme for the employment of City Managers for communities from the smallest villages to the largest cities and believed that capable, well-trained men should be used in this connection. Since that time, a considerable development has taken place, and we now have a large number of municipalities under the city management scheme. This is all very well and has resulted in considerable economy up to this time. However, a word of caution should be given the city managers and prospective city managers as to the conduct of their office.

It has come increasingly to the writer's notice that the city manager, as a usual thing, is becoming too ambitious, and I believe this is detrimental to all systems of city management. It is understood that I am not attempting to disparage city managers but rather encourage them along the management line. Many of these men are engineers who have had an engineering education, with perhaps not much practical work or much chance to apply their professional knowledge. In other words, they lack the broad experience necessary to design engineering work. They naturally have but a small amount of time to devote to any one object or any particular improvement other than to manage the financing and the large number of details in connection therewith. From loss of association with engineering works, even though they may

be experienced engineers, they are unable to know costs, the advance of the science and other things known to the consulting engineer who is handling many different classes of work of varying natures every day in the year.

There is no place where it is possible to point out the savings that can be made in the proper handling of engineering work other than the way in which it has been executed. In other words, it may, and usually does, cost a municipality a much larger amount of money to have the city manager prepare plans and specifications for certain work than it would to have these plans and specifications prepared and the work supervised by a consulting engineer in regular practice. This fact never comes to the surface as there is no chance of making a comparison as to what the work should cost.

The fact is the consulting municipal engineer of today, if he is worthy of the name, is able to draw plans, specifications and complete designs and supervise construction in such a way as to eliminate all unnecessary expense in the projects. Not only does he make a particular study with all the data he has in mind of previous situations but in the course of his career, through his experience with perhaps one or two hundred clients, he has naturally made some mistakes from which he has learned how to avoid their repetition. The ordinary city manager has perhaps designed several successful plants which he may or may not have done in an economical manner. He is not in a position to determine these points as he has nothing to compare with in his daily work nor does he have the time to make such comparisons and studies. Therefore, the live and wide-awake city manager should hesitate a long time before attempting engineering designs. His hands are full of other work and his brain acting along lines which would not contribute to economical engineering design.

In other words, I believe that the city manager is attempting to handle more work than he should and is entering the field in competition with the consulting municipal engineers, and this only means disparaging his management by so doing. The city manager should be the first to recognize the necessity of securing first class consulting engineers for the purpose of the design and execution of public work and should be the first one to suggest such employment. This does not show a weakness on his part, but rather a strength of character which will be reflected in his duties as city manager. In other words, I believe that the city manager of today should be the first man to recognize the advisability of the employment of experts in all branches when such services are required, and should not, himself, attempt the solution of engineering problems. Should he do this, there is not a first class consulting engineer in the country who would not recommend to his municipal clients the employment of well-trained city managers as a solution of much of the unwise expenditure of money now taking place in the municipalities and the gathering up of loose ends of public administration.

THE PUBLIC UTILITY FUEL PROBLEM

By C. M. Roos, Secretary-Manager Cairo Water Co., Cairo, Ill.

During the world war fuel was among the many commodities needed for the proper carrying on of the great struggle, and without murmuring our people submitted to all sorts of inconvenience and paid exorbitant prices for essential commodities. It is one of the characteristics of the Spirit of America to which we point with pride, to be willing to pay dearly for victory in maintaining her position as the champion of liberty and justice. But that same spirit frowns upon unfair, unjust or unnecessary conditions which fail to protect or recognize the welfare of the majority in order that a small minority may enjoy special industrial or commercial privileges.

Coal prices were high during the war and there was a reason for it which was understood and accepted by our people. Coal prices since the war have averaged or ranged even higher than during the war, and there is also a reason for it, but that reason is well enough understood to warrant the uncompromising statement that the present high prices for fuel are unnecessary and unwarranted.

This statement is not made to place the entire responsibility for high coal costs upon the retailer, the transportation lines, the miner or the mine operator; neither can the entire blame be charged against all of these classes collectively. The condition exists as the result of failure thus far on the part of our Government to adopt a sane and common sense plan to regulate and direct the coal industry

which has such a vital place in our entire economic structure.

The coal situation as a whole is one which, without any one group within the group being responsible for results, runs away with itself, defying interference, resenting criticism and comment, and doing all sorts of damage.

The author of this paper recently made an attempt to show the necessity for regulation of the coal industry, comparing the industry with our public utilities, all of which are now to a greater or less degree under some form of government supervision.

On account of the rather uncompromising manner in which the subject was treated, this article attracted widespread attention and comment, part of which is very interesting and amusing. Coal men as a whole resented the fact that a mere consumer dared express himself in regard to the coal situation. Some looked upon it as a case of "sour grapes," that because the public utilities have been caught within the merciless meshes of public regulation, they now desire to drag down to ruin with them the coal industry.

Regardless of misunderstood motives, and regardless of well meaning, conscientious and absolutely honest individuals and departments in the coal industry, the present status of the conduct of this industry as a whole is basically wrong, and it should be remedied in a safe and sane manner. It should not be a difficult task to accomplish this.

In its recent report to the President of the United States the Federal Coal Fact Finding Commission discusses its investigations at some length, and then sums up the situation by stating that the coal industry in our country is overdeveloped, with too many mines and too many miners. Figures and statistics are given to prove this statement. Each ton of coal purchased by the consumer must carry an exorbitant charge to cover the cost of overdevelopment in the coal industry as a whole.

It is obvious to anyone that the remedy for such a condition must lie in regulating the number, location and character of mines, and when the mining wage scale is properly and fairly adjusted or handled, the problem of an excess number of miners will take care of itself because everybody will not want to be a coal miner as at present. When a man can earn more money digging coal a few hours per day than the salary received by the executive head of some struggling industry, it is easy to answer the question why we have almost double the number of coal miners that are needed. An excess number of miners is just as much a contributing cause to the present coal situation as an excess number of mines.

Effect of Coal Prices on Water Utilities

The average water utility is probably affected more by fluctuations in coal prices than other industries, for two reasons:

(a) Power is the largest single expense item of the average water works.

(b) The margin of profit allowed water utilities by our regulatory bodies is smaller and less flexible than any other class of utility.

Power is coal, whether used directly from a utility's own power plant or otherwise. Changes in water rates are very expensive and difficult to secure. Sudden fluctuations in coal prices (and a coal price fluctuation is usually upward), leave the utility without a margin to cover such increased expense.

Fortunately many water utilities are located within almost a stone's throw of coal mines, with the result that when the coal pinch comes they can manage to buy, borrow or steal fuel on some basis within reason. Water utilities not so favorably situated have a different story to tell.

The Cairo Water Works Coal Story

The story of the Cairo Water Works and its 1922 coal supply may be of interest and even if it is not instructive it may be at least entertaining and is a strong argument in favor of proper regulation of the coal industry.

It is not without the full knowledge that it is not thoroughly orthodox to fill our organization's records with other than technical statistics and figures, that this story is given. Amusement is a delicacy, however, for which we sometimes pay dearly, and it may be worth having a paper "ruled out of the records," to be able to mix in with the serious deliberations of a pious group of water works men a story which savors more of romance as it is viewed from a distance than as experienced at the time by the one on the ground who played the leading role.

Cairo is often thought of and referred to by "outsiders" as a place "With water, water everywhere and not a drop to drink." That part of this statement which refers to the water is always persistently disputed and resented by all blue blood Cairoites, as they will proudly tell of the greatest levee system in the world and to the only city in the river valleys which has never been flooded.

The proper statement which some have confused with the water story is "Coal, coal everywhere and not a pound to burn." In 1922 there was coal to the right of us, coal to the left of us, coal in front of us and coal in the rear of us, and it also volleyed and thundered. From the blood curdling Herrin massacre to the rumblings of the uncontrolled passions in the Kentucky coal fields, bloodshed and riot were the order of the day. Coal deposits in almost unlimited quantities are to be found in Illinois just north of Cairo, also in the Kentucky coal fields just across the Ohio river, and in the coal fields up the Ohio river from which shipments are made by river barge.

The water works man needed fuel to avoid breaking a record of operating his plant continuously without a single shutdown for ten consecutive years. Wise looking veteran coal men kindly advised him that he need not worry, that the coal strike would not last long, and added the old threadbare statement, "the people and the government will not stand for it."

When the coal shortage and high prices led the water man to decide that action was more virtuous than discussion and watchful waiting, he acted and acted entirely upon his own resources without the direction and legal assistance of engineers or lawyers, or the aid of a report from a fact finding commission.

His first move was to secure a nearby tract of hardwood timber, lease a portable gasoline operated wood sawing outfit, and organize a bunch of husky wood cutters. The wood was cut into 30-in. lengths and shipped in carload lots to the waterworks switch. As soon as this plan was well under way and success was assured, the horizon was scanned for other worlds to conquer as it was discovered that to burn wood to good advantage coal must be mixed with it. Coal then was the next thing needed, and there was no disposition on the part of the water man to pay $14 per ton for a product which should sell for not more than $2.50. The only solution seemed to be to go to the coal fields and actually dig the coal from under the ground. It was soon found that coal above ground was a product so madly sought and still more madly manipulated that a water works man and his purse couldn't last long under such conditions.

The Herrin massacre instinctively led the would-be coal miner to turn his face southward instead of northward as he gazed wistfully into the distance looking for something like coal at less than $14 per ton.

Early one morning while the rest of the world remained asleep, mounting his trusty steed in the form of an old Maxwell auto, the daring prospector, true to style with a gun in the tool kit, started out into the wildest, rockiest, roughest part of Kentucky in search for coal. After many weary days of arguing, negotiating, and prospecting around sections where rioting and bloodshed were almost daily occurrences, coal began to move to Cairo in cars marked "Cairo Water Company."

The story of personally shoveling coal, dodging the suspicious and prejudiced coal miners, employing farmers with teams for as much as $20 per day to haul the coal to the cars, being in a section where checks would not go, making it necessary to carry actual cash on one's person to meet the necessity of paying labor every night, etc., would be too long to include in an article like this. But results were obtained.

The rather spectacular efforts herein referred to could have been avoided if the water works management had felt justified in raising funds with which to buy coal at $14 per ton and operate the plant at a great loss. The action as taken was prompted by a determination to win in a fight against an outrageous condition in the coal industry, which should not have been allowed to exist and for which there was no real excuse.

As part of the proof of the results obtained by its most unusual methods, the Cairo Water Company's fuel account for 1922 shows an average cost equivalent to $3.87 per ton for coal, including from $1.25 to $1.50 freight rate per ton, and 10 cts. per ton for unloading.

We have no coal strike in 1923. The average coal costs thus far this year, however, for this same plant are just about as high as in 1922.

The serious question before the water utilities in Illinois is, are we satisfied to sit in silence and not endeavor to find some way to reduce our fuel or power costs? Is there not some way by which our interests can be better served by combining our coal buying or procuring powers? With an abundance of coal within such easy reach, at our very doors, do we not have the initiative, ability and power to get enough of it to run our plants at a fair price?

The foregoing paper was presented at the recent annual convention of the Illinois Section of the American Water Works Association.

RIGID "STANDARD" PRACTICE VS. COMMON SENSE

By George C. Warren, Chairman Executive Committee, Warren Bros. Co., Parkman Bldg., 9 Cambridge St., Boston, Mass.

Deeply interested in two unusually valuable articles in Municipal and County Engineering, issue of November, 1922, I hope an addition to the subject may be of value and interest to both practical and technical road construction men. I refer to the articles:

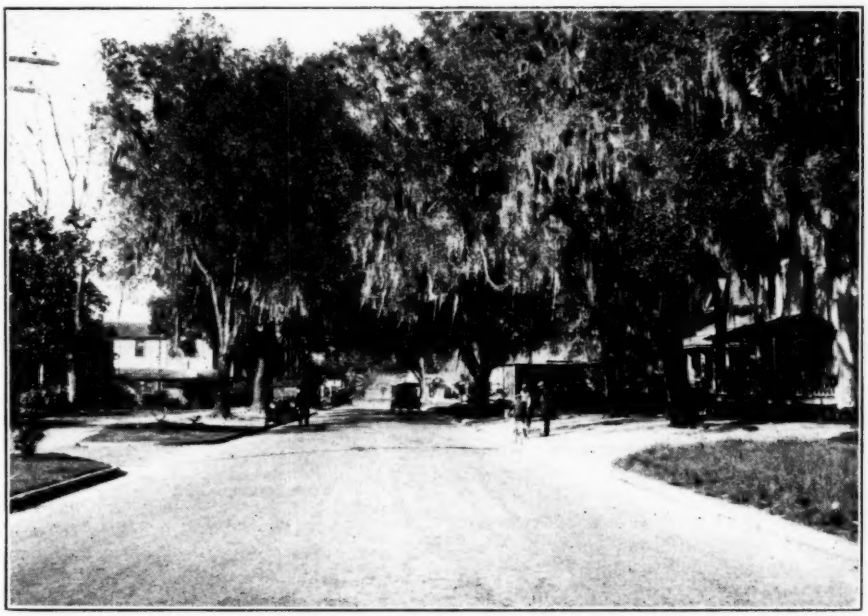
1. "Standard and Standardization," etc., page 162, by the always practical and forceful pen of one of the fathers of high grade street construction—George W. Tillson, C. E.

2. "How Good Roads Developed Polk County, Florida," pages 171-172, in which special reference is made to the extraordinary and great non-standard "Bartow Clay" foundation as a prime cause of economical construction both as to Polk County roads and city pavements of Bartow, which is the county seat of Polk County.

Illustrative of the essence of the present consideration may I quote two sentences from Mr. Tillson's timely and highly practical article as follows:

"One point must be considered here. A standard is supposed to be the best of its kind. But in practical work what is theoretically the best is not always economically so. The writer was once called down quite severely by his professor in college when in an essay on 'Foundations' he made the statement that rock makes the best foundation, the professor's argument being that oftentimes sand is as good as rock.

"The writer has always been strongly in favor of standards and standard specifications, but wishes to reiterate what he has previously said that they should be used understandingly with a knowledge of why this thing or that is required, so that any omissions or additions may be made without producing a document that would be inconsistent and of little value."



1923 VIEW OF WARREN PAVEMENT LAID ON BASE OF "BARTOW CLAY" ON MAIN ST., BARTOW, FLORIDA, IN 1914.

Very many engineers hew too closely to text books and more or less theoretical lines rather than provide practical variations from them to meet peculiar local conditions economically, both in writing specifications and in carrying out construction under them.

Bartow Clay

This brings us to the "Bartow Clay" matter. There is probably no text book writer or college professor who would have thought of suggesting this as a first class foundation for high type, expensive road construction which it has proved to be. We quote from the article:

"To keep the cost down, local products were used almost exclusively in the construction work, the clay being taken from the Bartow clay pits and local soft phosphate rock being often used for the base."

The writer's attention was first brought to this material in the year 1913, when he was asked advice as to whether or not it would make a suitable foundation for the Warren pavement it was proposed to adopt in Bartow. The material was described as a soft phosphate clay, which could be ground and if brought to the street in quarry-sizes, up to say 10 ins. and spread on the sub-grade it would so crush under the roller as to provide a solid roadbed of uniform contour, even resembling Portland cement concrete in appearance.

The drainage was reported as good. The writer hazarded the opinion, that while contrary to all established standards and rules governing road construction, such material would prove to provide splendid foundation for dense stable bituminous wearing surface, even under heavy city traffic. The result has been more than satisfactory, as shown by the following quotations from a letter, dated Jan. 13th, 1923, from Mr. J. W. Greer, City Manager of Bartow, and the accompanying photograph sent by him:

"The bitulithic pavement you put down here in 1914 on Bartow Clay foundation is in fine shape.

"I have examined the paving closely and have also examined into the merit of the Bartow foundation. From the length of time the pavement has been down and the fact that it is on the Main Street of the City and in both the business district and the residence district, and the further fact that all the business traffic and the haulage and passenger traffic to and from the union railway station is done over this pavement it would seem that the Bartow Clay foundation is all that could be desired and the pavement first class in every respect.

"There are no cracks, either transverse or longitudinal, no folds or ravels in the pavement and the topping seems as perfect as when placed barring the slight wear from constant use for eight or nine years."

Characteristics of Bartow Clay

The following additional information with reference to Bartow Clay is from a private report by George O. Tenney, President of the Atlantic Bitulithic Co. of Washington, D. C., dated March 2, 1922:

"This Bartow clay is mined by blasting and comes out in chunks. We hauled it to the street and leveled it off, but the surface was very irregular. We then wet the phosphate clay in the street and allowed the water to dry out somewhat before putting on the roller. We were then able to smooth out the surface, as the water melted down the lumps.

"Before the clay had thoroughly dried out, we scattered 1 in. stone over the surface so as to about half cover the surface and then thoroughly rolled it, squeezing the stone down in the phosphate clay. After the street had been thoroughly rolled, and it had entirely dried out, it looked exactly like a concrete foundation. This is an exceptionally good material for a base; in fact I hardly believe any other material would be anywhere near as good. As a general proposition in the location of Bartow, this clay is being used without the addition of the stone."

IOWA TRANSPORTATION PROBLEMS AND SUGGESTED SOLUTIONS

By C. C. Coykendall, Assistant Chief Engineer, Iowa Highway Commission, Ames, Iowa.

Iowa's highway transportation problem, briefly stated, is that of improving and maintaining a rural highway system of approximately 104,000 miles in a manner adequate to traffic needs. No small problem, it must be admitted, but by no means one impossible of solution. The one and only really essential thing necessary to make the solution of this problem an absolute certainty is for the people of Iowa to decide that an improved system of highways is really needed in Iowa. When that decision is reached, the speed with which highway improvements will be accomplished in Iowa will amaze the most optimistic good roads enthusiast.

Money Can Be Raised

Ample proof is easily found for the accuracy of the foregoing statement. During the last decade approximately three-quarters of a billion of dollars of Iowa money has been invested in automobiles. Annually we are spending approximately one hundred million dollars in renewing and increasing our motor vehicle equipment. Evidently Iowa feels that she needs automobiles. School taxes are now being paid at the rate of fifty million dollars

annually, and how many really serious grumbles do we hear on this account? How many forward-looking, serious-thinking persons believe that there is any prospect of our school taxes being lowered? Not one. As the years go by our expenditures for educating the youth of the State will steadily increase. For Iowa long ago decided that her children need and are entitled to educational advantages second to none. All over Iowa, in county, town and city, many millions of dollars are being spent annually in building modern, comfortable homes. The people of Iowa have decided that such homes are needed and are proceeding to build them. Why, then, should our highway transportation problems alarm us? A study of the problem shows that it consists entirely of providing adequate and equitable means of financing road improvements, and Iowa has in many ways demonstrated her power to pay for what she needs.

Highway Progress in Iowa

In order that a proper understanding of our highway transportation problem may be had, a brief statement as to what has been accomplished toward the improvement of our highways is in order. Actually, much more has been accomplished than most people realize. Outstanding and fundamental among these accomplishments is the classification of highways, from a consideration of the traffic served, and the fixing of responsibility for the improvement and maintenance of the various systems into which the highways have been classified.

The Primary System

At the present time our highway system is classified into primary and secondary roads. Approximately 6,615 miles of main highways are included in the primary system, and the remaining mileage is included in the secondary system. The primary system includes the roads of state or interstate importance, and is the system upon which, by Federal statute, Iowa's share of Federal aid appropriations must be expended. Responsibility for the improvement and maintenance of the primary system is vested jointly in the county boards of supervisors and the State Highway Commission.

The Secondary System

The secondary system is further classified into county and township highways. Approximately 11,000 miles of the secondary system, including the roads which are of importance from a county standpoint, are county highways, and are under the direct supervision of county officials. The remaining mileage of approximately 87,000 miles is in the township system and is under the jurisdiction of the township officials. Inasmuch as the primary road system is the system in which the state as a whole is most interested, and is the system which carries a very large percentage of the total traffic upon the highways, we will first consider the problem of improving the primary road system.

Improving the Primary Roads

Of the total mileage of 6,615 miles of primary roads, when work now under contract is completed, there will remain approximately 2,750 miles to be constructed to established grade and the necessary drainage and drainage structures installed. Approximately 335 miles of this system have been paved, and approximately 1,560 miles have been surfaced with gravel. It will thus be seen that real progress has been made toward completing the construction of roads to established grade—a necessary preliminary step, whatever the nature of the ultimate improvement—some progress has been made toward the gravel surfacing of the system,w hile the hard surfacing has barely been commenced.

Differences of Opinion

In considering the further improvement of the primary road system, let us first attempt to determine definitely what we are striving for. It is always well at least to think that we know where we are going before a start is made. Anyone who has made any study of the primary road problem in this state finds that there is a wide difference of opinion as to what type of improvement is necessary properly to take care of traffic upon the primary road system. Practically everyone will admit the necessity of having the primary road system graded, drained and bridged. Some, however, will not admit that there is any necessity for any pavement or any type of surfacing whatever. Others are against a paving program but consider a gravel surfacing as the ultimate and final solution. Still other enthuusiasts insist that no type of surfacing for the primary road system is worth considering excepting a pavement.

When Paving Is Economical

None of the attitudes above outlined, toward surfacing the primary road system, is the reasonable attitude. Those opposed to any type of surfacing are wrong. We cannot afford to have the 500,000 automobiles now owned in this state made useless with every heavy rain. The best

dirt road that can be built will not adequately serve traffic upon any part of the primary road system. The fallacy of the argument that a gravel surfacing is all that is needed on our primary road system, lies in the fact that gravel roads carrying a very heavy traffic cannot be so maintained as to give service comparable to that given by a paved road. Some gravel road enthusiasts argue that gravel roads can be built and maintained indefinitely at a less annual cost per mile than can paved roads, but what does this prove if traffic is not equally well served? Extensive investigational work recently carried on to determine the tractive resistance of various road surfaces, conclusively proves that it takes less fuel to operate motor vehicles on paved roads than on gravel roads. Consequently, when traffic upon any highway becomes sufficiently heavy, the saving in fuel costs to users of the highway makes it economical to pave it rather than to maintain it as a gravel road. The paved roads enthusiasts who insist that all of the primary road system must be paved and that no other type of surfacing should be considered, are wrong. The traffic upon all portions of the primary road system is not such at the present time as to justify the cost of pavement.

It is believed that the proper solution for the problem of improving the primary road system is by paving those portions of the system where traffic is heavy enough to justify paving, and surfacing the remaining mileage with gravel or similar material.

If one takes a map of the primary road system and is familiar with traffic conditions, it is not difficult to lay out a network of roads that should be paved. This system when completed will carry practically all of the interstate traffic and will also serve a large part of the traffic that might be classed as through traffic though confined to the limits of the state. A logically laid out system of paved roads must also include a number of heavily traveled roads radiating out from cities even though such roads may not be of much state or interstate importance.

In order that the problem might be reduced to definite terms, such a system has been laid out and tentative estimates of cost prepared. The proposed system of paved roads includes approximately 2,100 miles, and the program proposed includes the gravel surfacing of all the remaining mileage. It is not contended that the system proposed is perfect, or that anyone else would lay out identically the same system for improvement. Suffice it to say, however, that such a system as has been laid out and estimated, would provide a very usuable system of highways and would serve as well as any other system as a basis for discussion.

Five-Year Construction Program

Obviously, the carrying out of such a program must involve a considerable period of time, and for this reason it was assumed that the construction program would extend over a five-year period. During this five-year construction period, 2,748 miles of road must be built to established grade, 3,465 miles must be gravel surfaced, and 1,740 miles of pavement must be constructed. During this construction period adequate provision must also be made for taking care of all needed maintenance work. With this in mind, let us inquire into the difficulties likely to be encountered in the carrying out of such a program.

From the standpoint of construction facilities available, the grading, draining and bridging required to complete this class of work on the primary road system can readily be accomplished in two years. During 1922, 1,070 miles were graded, drained and bridged, and this performance could easily be increased sufficiently to build the 2,748 miles yet remaining, in two years. There is available for work in this state a large, well-equipped construction organization, capable of completing any reasonable amount of this class of work that can be offered. The only possible difficulty that might be experienced in carrying out the graveling program is in securing the necessary open-top cars for transporting surfacing material, inasmuch as a considerable portion of the mileage to be gravel surfaced lies in territory where surfacing material must be shipped in. The question of rail transportation, however, is the only possible difficulty in carrying out a gravel surfacing program of this size in five years. There seems to be no limit to the ability of gravel surfacing contractors to expand their facilities to take care of any amount of this kind of work within reason.

It is not thought that any difficulty would be experienced in constructing the 1,740 miles of paved road during the five-year period. The contracting facilities for constructing this class of improvement have greatly expanded during the past three years, and we now have within this state a competent contracting organization capable of building annually at least

400 miles of rural highway pavement. Substantial progress has also been made toward the development of the material resources of the state, and there is no question but that if a definite paving program could be authorized, the development of necessary materials would proceed rapidly and readily care for such a program as has been outlined.

From the administration and engineering standpoint no difficulty would be experienced in carrying out such a program. But little preliminary engineering work is required for carrying out a surfacing program after the system has been built to established grade. The present engineering, and the necessary expansion of the organization to take care of such a construction program could readily be accomplished.

Problem of Finance

The only apparent obstacle, therefore, to the carrying out of the program as outlined above, is that of financing it. Careful preliminary estimates of cost of the program as heretofore outlined, together with the necessary allowance for maintenance, shows an expenditure, based on present costs, of approximately $95,000,000 during the five-year period over which this construction program would extend.

It is estimated that the revenue becoming available in the primary road fund during this five-year period will total approximately $55,000,000. This estimate is based on the assumption that receipts from Federal aid and the licensing of motor vehicles will continue at the present rate, and that this fund will be supplemented by revenues derived from a tax upon gasoline, which will net the primary road fund one and one-half million dollars annually. The levying of a tax upon gasoline is not essential to the success of the program, but would reduce the outstanding indebtedness at the end of the construction period by seven and one-half million dollars. Incidentally, it will be noted that no special assessment is proposed in connection with the paving program. Based on these assumptions, the difference between the estimated expenditures and estimated receipts during this five-year construction program is $40,000,000, or approximately 80 per cent of what Iowa is annually paying for school taxes.

It should be made possible to finance this entire program from the primary road fund with no property tax or assessment of any kind, by anticipating future allotments of primary road funds, either through the issuance of certificates or bonds in those counties where the construction program amounts to more than the estimated revenue during the five-year period. Such certificates and bonds could be made wholly payable, both as to principal and interest, from the primary road fund, thus eliminating entirely the property tax feature.

It is not thought that the system of pavements as above outlined is by any means the ultimate mileage of paved roads that will be needed for carrying the traffic of Iowa. Rather, this mileage should be considered the minimum. At the end of the five-year program, without question a continuing program of paving construction would develop on those roads where traffic developments were such that the traffic could no longer be economically served with gravel or sand-clay surface. It is believed, however, that the program as outlined has this to recommend it: First, it does not involve an expenditure sufficiently large that it should in any way terrify the people of the state. Second, it provides a system of unsable roads in what is probably the minimum amount of time.

If funds should be provided in sufficient amount to pave the entire mileage of the primary road system, it is doubtful whether the task could be accomplished in less than eight to ten years. If it were, we would be making more rapid progress than any other state where large paving programs have been authorized, and that at a time when neighboring states have similar programs under way and would be competing for the materials, construction facilities, and rail transportation so necessary to the success of such a program. It is believed that the most urgent need of road users in Iowa at this time is a system of usable roads completed at the earliest possible date. For that reason this program proposes the immediate gravel surfacing of roads that within the next decade will require paving if traffic is to be efficiently and economically served.

It must be borne in mind that the program of improvement herein outlined for the primary road system is only one of many solutions that might be offered, and is not necessarily the most feasible one. The scheme proposed, however, involves no radical changes in existing laws and could be put into effect with a minimum of delay or confusion. The most important changes that would be required in existing laws to put such a program into effect would be in those sections pertain-

ing to the anticipation of future allotments of the primary road fund through the issuance of certificates or bonds.

In considering our highway transportation problems, we must not lose sight of the needs of our secondary road system. No state has provided adequate laws under which highways may be built, until provision has been made whereby any community may, if desired, improve the roads of the community in a manner adequate to traffic needs. In this particular the lawmakers of the State of Iowa have failed, inasmuch as under existing laws it is impossible for any community to make reasonable progress toward the building of an adequate system of community roads.

Financing Secondary Roads

There are two commonly accepted benefits resulting from the improvement of any system of roads—a community benefit and a benefit to the road users. If these two benefits are to be recognized in apportioning costs, it must follow that the cost of improving a system of community roads must be borne largely by the people living in the community served by those roads. If this is true, then the solution of our secondary road problems will be found through providing more adequate revenues for financing secondary road improvements, and efficient means of administering secondary road work after adequate finances have been provided.

As one solution for the secondary road problem, I would propose placing all secondary roads under the supervision of the county board of supervisors and county engineer. Inasmuch as county roads are of county-wide importance, the distinction between county and township roads should be continued and county road improvements should continue to be financed largely from tax levies spread over the entire county. Provision should be made whereby the people of the county could, if desired, anticipate county revenues through the authorization of bond issues, in order to more rapidly complete the adequate improvement of the county road system.

Financing Township Roads

Improvement on the township road system should be financed from the proceeds of a tax levied upon all property in the county, outside of the incorporated limits of cities and towns. The provision for the creation of secondary road districts in order to facilitate the improvement of secondary roads—both county and township—should be continued, with provision for assessing at least one-half the cost of surfacing against benefited property, instead of one-fourth of the cost as the law now provides. Improvement of secondary roads might be further stimulated by applying one-half the revenue derived from a tax upon the sale of gasoline toward the maintenance and improvement of secondary roads. An efficient organization and equipment such as the county could place on township roads would produce better results for the same expenditures than are now being secured. In addition to this, the county officials would probably levy township road taxes much more nearly approaching the maximum allowable than do the township officials. Such a policy might not be particularly popular with certain taxpayers, but it would produce more revenue for building township roads, and more revenue must be produced if any progress is to be made toward the improvement of the township road system.

The foregoing paper was presented at the recent annual meeting of the Iowa Engineering Society.

REHABILITATING OLD SEWER SYSTEMS

By William E. Stanley, Assistant Engineer, With Pearse, Greeley & Hansen, Consulting Engineers, Chicago, Ill.

The object of this paper is to present some observations regarding the present status of the sewer systems in many cities of this country; to point out briefly some of the underlying causes which have brought them to such a condition in their operation that we may term them "sick sewer systems"; to point out some of the symptoms of such a condition; to suggest general remedies; and to illustrate the application of these suggested remedies by reference to a number of typical cases which have come to our attention during the past few years.

General

The first sewerage plans to be prepared for a city in this country appear to have been for the city of Chicago. About 1855, Mr. E. S. Chesbrough was selected engineer for the Chicago Sewerage Commission to design a system of sewers for that city.

Following Chicago, a few of the larger cities had sewerage plans prepared. However, the construction of sewers for the smaller cities did not become active gen-

erally until after the publication in 1881 of Rudolph Hering's report to the National Board of Health, giving the results of an investigation of the sewerage systems of several European cities. Sewers began to be built in a great many cities about 30 years ago. These systems have been added to at intervals as the cities grew.

Design and Status of Many of the Present Sewerage Systems

Many of the sewers built have been constructed without any regard to a general comprehensive plan. The tendency has been to build in a haphazard way each section of sewer to meet the needs of the moment only, or to suit the whim of some person with little or no engineering knowledge and with no plan for future extension.

Some cities had sewerage plans prepared and either lost or ignored them. Not all, however, of our present sewer systems were built without comprehensive plans. A considerable number of cities had careful plans prepared by able engineers who considered the future development of the city. The cities which followed definite plans in the construction of sewerage systems have escaped the ever increasing troubles encountered by the communities with the haphazard systems. The original plans for the cities of Superior, Wis., and Elgin, Ill., among others, are examples of some of the earlier comprehensive work.

At Elgin, Ill. we have had occasion recently to look over the plans for sewerage prepared by Samuel M. Gray in 1892 and have found them remarkably well fitted to the present needs of the city. Present troubles come in some measure through deviations from the original general plan.

Many sewers have been built to take care of domestic sewage only, while the storm water was allowed to take care of itself. Later as the cities became more thickly populated and street paving was started, it became undesirable to permit the storm water to follow its natural channel across lots to the nearest water course. As a result many street inlets have been connected to the sanitary sewers. In other cases where storm sewers have been provided with the street improvements a great many roof water drains have been improperly connected to the small sanitary sewers.

The result of such haphazard construction of sewers without a general sewerage plan and very little regard for the future development of the community is that many cities have come to the point where further development of their sewerage is at a standstill. Many other cities are fast approaching such a condition. The present sewers are frequently surcharged and the people connected to them protest against further extensions which will add to the surcharging. Thus we have what we may term "Sick Sewer Systems."

Symptoms of a Sick Sewer System

The principal symptoms of a "sick sewer system" may be briefly classified as follows:

First.—The frequent surcharging of sewers. This condition is due to an insufficient capacity to carry the load connected to the sewer, which may be due to a number of causes. In some cases sewers originally built to handle domestic sewage only have had so many storm water connections made to them that they are overloaded at each light rain. In other cases the original sewers either had insufficient capacity to start with because of improper size or grade, or else the lines have been extended to serve territory not considered when the sewers were originally constructed. The capacity of some sewer lines has become insufficient because of clogging by tree roots or by structural abuse of the tile by careless and irresponsible parties in making house connections.

Second.—Inability to make extensions. The extension may be impracticable and in many cases impossible because of a lack of foresight in the construction of the sewer lines. The lines either were built with too small capacity or at too high elevations to permit of extension into the territory which should logically be served by them.

Third.—Difficult house connections. Very frequently many new houses built along sewer lines are either unable or have difficulty in making connections to the sewer because the sewer is too high or too small. Other houses which are built in areas supposedly sewered, find it necessary to go considerable distances in order to reach a sewer line.

Fourth.—People in new areas do not know what to do for sewerage. Frequently these new areas which have been developed lie at considerable distance from any point where domestic sewage may be disposed of. The expense of an outlet sewer is too great for the people in the new area to finance.

Fifth.—A considerable pollution of streams. The natural drainage of a part or all of some cities is into small water courses. The first sewers were built in the direction of the natural drainage with outlets into the small water courses. At first little or no pollution was noticeable, but as the cities grew the pollution increased until it has become a serious nuisance if not a menace to the public health. In numerous cases successful damage suits have been pressed against cities by property owners downstream because of the pollution of the stream.

Sixth.—Intercepting sewers difficult to build. The existing sewers are very frequently located in the bottom of ravines or valleys with their outlet elevation so low that interception of the sewage is difficult and sometimes impossible without pumping. In other cases there are many outlets which make expensive intercepting sewers necessary.

As the status of an existing sewer system may be judged by the above considerations, conversely, the merits of a comprehensive sewerage plan may be judged in a general way by the extent to which the designer looked into the future and provided against such difficulties.

Remedies

The first step in remedying a sick sewer system should be an extensive and thorough engineering investigation and study of each individual case. All available records and maps of the existing sewers should be collected and, where necessary, supplemented by field work, so that relatively accurate knowledge can be obtained of the location, condition and capacity of the existing sewers.

The object of the engineering investigation of the sick sewer system should be to evolve a comprehensive plan of sewerage which will utilize the present sewers to best advantage, provide relief sewers for critical areas, and which will be adequate for 40 to 50 years in the future.

Typical Problems

The following are a number of typical cases of sick sewer systems which illustrate the conditions which exist in many communities. A brief description is given of the situation and the remedies which were suggested after a thorough investigation of each case.

Streator, Ill.

Streator is located in the North Central part of Illinois, on the Vermilion River. It is a relatively old and well established city, which had a large coal mining industry up to 10 or 15 years ago. Although coal mining is now much restricted, the city has large tile and glass industries and other well established manufacturing interests.

The population, by the 1920 Federal Census was a little less than 15,000, and the estimated population for 1960 was 30,000. Sewer capacities have been recommended for this population.

The drainage of the city is into the Vermilion River, which has a drainage area above Streator of about 952 square miles. Two creeks cut the city into drainage districts.

The first sewers were built in 1880. The first sewerage plan was made up in 1891, at which time a large number of small sewer districts were planned largely without reference to each other or to the earlier sewers. Very few records of actual construction were kept.

Many of the existing sewers are overloaded, and frequent flooding of streets and basements result. Some sewers are large enough for only domestic sewage, while others still give good service for both domestic and surface sewage. Most of the existing sewers are used as combined sewers, notwithstanding the inadequate capacity.

The existing sewers discharge at the most convenient points into the Vermilion River, or the two creeks. A short intercepting sewer has been attempted. There is considerable nuisance along the two creeks. All the sewage eventually reaches the Vermilion River, and at times constitutes almost the entire flow.

The water supply is taken from the river above town. The average consumption is about 200 gal. per capita per day, of which it is estimated 160 gal. per capita reaches the sewers.

The engineering investigation of the situation at Streator indicated that their needs for sewerage are briefly as follows:

(a.) A general plan is needed so that new sewers can be built with the certainty that they will afford satisfactory service. An adequate general plan for sewers is one of the first essentials of a progressive community.

(b.) Some of the existing sewers are too small. New and relief sewers should be built so that adequate sewerage capacity will be available to all parts of the city.

(c.) Nuisances now exist through the discharge of untreated sewage into the creeks and the Vermilion River passing

through the city. The construction of intercepting sewers is necessary to relieve this condition and to discharge the sewage down stream of the city in such a way as to permit of sewage treatment when that becomes necessary.

Portsmouth, Ohio.

Portsmouth is located in the hilly region of the south central portion of Ohio facing on the Ohio River at its junction with the Scioto River. It was incorporated in 1814 and has a frontage of some eight miles along the Ohio River including the small city of New Boston.

The leading industries are the manufacture of shoes, stoves, brick, and knit goods. There are also quite extensive railroad shops, while the City of New Boston has steel mills employing over a thousand.

The population according to the 1920 census was 33,011 but annexation and growth have increased the present population to over 40,000. It is estimated the population will reach from 85,000 to 100,000 in 1970.

The older city of Portsmouth has been provided with sewers for many years. These sewers are so overlapping that it is difficult to describe them briefly.

Both separate and combined systems are in use. However, the major portion of the sewers are intended to be on the separate plan. The larger sewer districts in general are tributary to four pumping stations which come into service at times of flood stage in the Ohio and Scioto Rivers.

The need for improved sewerage is emphasized in Portsmouth by the lack of a general sewer plan. It is difficult to provide for sewer extensions into new areas. Some of the existing sewers are of insufficient capacity, so that new and relief sewers are needed. A considerable sewage is discharged directly into Lawson's Run along the east side of the older part of Portsmouth and into other small creeks causing very objectionable nuisances.

The difficulties with the sewers and especially the nuisances caused by the pollution of the small creeks reached such a bad state that the State Board of Health has ordered the city to remedy the situation.

In Ohio the State Board of Health has police power to order city officials to remedy such conditions and can authorize a bond issue beyond the otherwise legal bonding limits of a city to provide funds for effecting the remedies. Under section 1260 of the Ohio General Code the city officials are subject to a heavy fine if they refuse to obey the ruling of the Board of Health.

The question of sewage treatment required considerable study in connection with the investigation of the sewerage problems at Portsmouth. Up to the present time it has been generally considered that there is a sufficient flow of water in the Ohio River to dispose satisfactorily of the tributary sewage by dilution. However, this problem is being studied at present by the U. S. Public Health Service. It has been generally held, that some form of treatment will be needed before many years and sewerage works at Cincinnati and Louisville for instance have been planned, so that sewage treatment plants can be added when required. On account of its critical location above the water intake, it is necessary to include a treatment plant in the plan for sewerage for Sciotoville, a recently annexed section of Portsmouth where there are no sewers at present.

As a result of an extensive investigation of the sewerage problem at Portsmouth a number of relief sewers were proposed in the older part of the city. New sewers were proposed to serve new areas, and intercepting sewers, were proposed to clean up pollution along small creeks.

All of the projects should be built in the immediate future except perhaps a few small lateral sewer lines. The total estimated cost of the projects is $383,000 of which $101,000 is for a large intercepting sewer in Lawson's Run to remove the pollution and another $132,000 is for the complete system of sewers in the Sciotoville section.

The proposed new construction may be financed in three ways, the sewers for new areas such as the sewers in Sciotoville by assessments for local improvements; the relief sewers by general bond issue; and the removal of pollution from the small creeks, Lawson's Run in particular, by funds from a special bond issue permitted by virtue of the State Board of Health order to clean up the unsanitary conditions now existing. Final decision has not yet been made regarding methods of financing to be used.

Washington Court House, Ohio.

Washington Court House, another of the older Ohio cities originally laid out in 1810, is located in about the middle of

the southwesterly quarter of Ohio. It is about an equal distance from Columbus and from Dayton. Passing through the city are the Baltimore and Ohio; the Detroit, Toledo and Ironton; and the Pennsylvania railroads.

The city is the center of a well developed farming territory. The principal industries include a creamery, two canning factories, a fertilizer works, a creosote company, and a packing company.

The population by the 1920 federal census was 7,962. The future population is estimated at 15,000 in 1970 which figure was used in computing the capacity of sewers for domestic sewage.

At present there are a considerable number of sewers in Washington Court House. These appear to have been developed piecemeal by gradual extension under pressure of individual need for the various districts. Portions of the sewer system appear to have been built in part as land drainage systems, and the drains thus laid have been extended to serve not only as storm sewers, but also to take care of domestic and roof water. No records of design or plans were available. There are at present some 30 different sewer outlets into Paint Creek, a small water way with 65 square miles drainage above Washington Court House. There are almost no manholes along the present sewers.

The lack of a general plan has made sewer extensions difficult. In some portions of the city some of the existing sewers are too small to carry both domestic and surface sewage and as a result basements are frequently flooded.

The discharge of domestic and industrial sewage from the present sewers into Paint Creek passing through the city has resulted in very objectionable odors and nuisances. During periods of dry weather there is very little surface water flowing in the creek.

The problem to be solved at Washington Court House was that of providing a general sewerage plan which will relieve surcharging of present sewers, provide sewerage for areas at present unsewered, and to remove the pollution from Paint Creek.

For comparative consideration, projects were prepared for a combined system of sewers and also for a separate system of sewers including both storm and sanitary sewers. An intercepting sewer was also included which is generally applicable to both systems. The project calling for combined sewers was considered the most desirable for the conditions at Washington Court House.

The main intercepting sewer will be along the east and north side of the creek extending from the northern section of the city to a sewage treatment plant site in the eastern part of the city. A second intercepting sewer will extend along the south side of the creek to a crossing some distance above the treatment plant.

The intercepting sewers were designed to have a capacity of 500 gal. per capita per day at the upper end and 400 gal. per capita per day along the lower sections for the population estimated for 1970. Sanitary sewers were designed for 300 gal. per capita for the estimated population tributary in 1970.

Combined and storm sewers were designed for a capacity based on a rainfall intensity at the rate of 12 divided by the square root of the time of concentration in minutes with a run off of 20 per cent. This intensity of rainfall as judged by records at Cincinnati is not likely to occur more frequently than once in three years and was considered ample for Washington Court House conditions. Storm water overflows are contemplated at points where the intercepting sewer and combined sewers meet.

The treatment plant proposed for ultimate development comprises in addition to the pumping station, an Imhoff tank, sludge beds, sprinkling filters, and secondary settling tanks. The first installation would call for one settling tank of the Imhoff type for a tributary population of 9,000; a sprinkling filter with an area of 0.36 acres; secondary settling tank of the Dortmund or Dorr type and disinfection by liquid chlorine when disinfection is necessary. However, the present sparse population down stream may permit omission of the sprinkling filters and secondary tank for a few years.

The program for present construction includes the construction of the intercepting sewers, the first installment of the sewage treatment plant, and a few main relief sewers and main sewers to provide outlets for areas not at present sewered.

The first item to eliminate the gross pollution of Paint Creek by the construction of intercepting sewers and partial treatment works was estimated to cost from $150,000 to $160,000.

The second step would be the construction of trunk line sewers extending into various sections of the city. The total

including intercepting sewers, partial treatment plant and suggested trunk sewers would be about $195,000.

If complete sewage treatment works are later required the estimated cost of the project outlined above except with complete treatment works was estimated at $243,000. To further extend sewers into districts of the city not now provided with sewerage service would bring the total estimated cost to $431,000.

The cost of sewering the entire city with separate sewers for domestic and storm sewage including new storm sewers on streets now having sewers and including complete treatment works was estimated at $636,600.

Washington Court House has its maximum allowable bonded indebtedness so the financing of the sewerage improvements will have to be taken care of by local improvement assessments and by bonds which can be authorized by the State Board of Health in case of emergency to build the intercepting sewer and treatment works.

Henderson, Ky.

Henderson is located on the Ohio River about 30 miles above the mouth of the Wabash River. It is an old city the original town having been laid out by a Colonel Allen in 1797.

There are a number of substantial industries in Henderson which include several tobacco warehouses, a nicotine plant, a large cotton mill, a catsup factory and several smaller establishments. Adjacent to the city to the east and south are a number of coal mines. The main line of the Louisville and Nashville railroad and a branch line of the Illinois Central pass through the city.

The population in 1920 according to the federal census was 12,169. It was estimated that the population of the city would reach 25,000 by 1960 of which 20,000 will be within the present city limits. This would be equivalent to an average density of ten people per acre.

The city is located on high ground not subject to overflow, and the drainage for the larger portion of the area is away from the river into Canoe Creek, a small waterway which passes along the east side of the city and enters the Ohio River some distance below the city.

Plans for a separate system of sewers were prepared in 1894 by Col. George A. Waring Jr. This system of sewers, however, was not built. A considerable part of the city is provided with sewers, some of which discharge into the Ohio River and others into Canoe Creek. These sewers seem to have been built without any reference to a general plan. The larger sewers were laid in the bed of former drainage ditches and were not placed low enough to drain basements.

The principal needs for improved sewerage were found to be as follows:

a. Relief for many of the present sewers now of insufficient capacity.

b. A general plan for the extension of sewers into areas not now sewered.

c. Elimination of the sewage pollution in Canoe Creek.

As connected up none of the present sewers have sufficient capacity to carry both domestic and storm water sewage; however with proper relief the use of the present sewers as combined sewers can be continued.

Five sewer outlets discharge into Canoe Creek and during dry weather odors and nuisances result. Certain property owners along Canoe Creek below the city file damage suits each year. These suits cannot be successfully defended by the city and have cost the city several thousand dollars annually. The drainage suits are such certain successes that it is claimed locally that certain property owners downstream attempt no other development of their property.

The project recommended to remedy the situation in Henderson was developed to discharge as much sewage as possible by gravity into the Ohio River. The principal features of the project comprise high and low level intercepting sewers along Canoe Creek and a 6 ft. combined sewer cutting through the ridge near the center of the city which will carry the sewage of a large portion of the city to the Ohio River.

Combined sewers were proposed for the area which can be drained into the Ohio because it was found that the most economical outlet for storm water is to the Ohio rather than to Canoe Creek owing to the high elevation of Canoe Creek and the general topography of the city. Separate sewers for domestic and storm sewage were proposed for the area which drains directly to Canoe Creek with capacity, however, in the sanitary sewers for roof water from 67 percent of the houses. The domestic sewage is to be collected to a pumping station and pumped into the upper end of the large sewer extending through the center of the city to the Ohio River.

Storm water sewers were designed for a capacity based on rainfall intensities

equal to 8.5 divided by the square root of the time of concentration in minutes and considering a run-off factor of 20 percent in the outlying areas and 30 to 40 percent in the downtown sections. Rainfall records at Louisville indicate that this rainfall is likely to be exceeded once to twice per year. However, at present and for years past there has been flooding in Henderson at each rainfall without excessive damages. Probable increase in property values hardly warrant a greater protection from storm water than that provided above.

There does not appear at the present time to be any need for treatment of sewage discharged into the Ohio River from Henderson. However, the new sewers proposed were maintained at elevations, so that an interceptor can be built in the future for concentrating the sewage at one point for treatment. The present sewers discharging into the Ohio River will also permit the building of such an interceptor.

The sewers suggested as desirable for near future construction have a total estimated cost, including allowance for financing and engineering and contingencies of $326,000.

The funds for financing the projects of Henderson may be raised by special assessment proceedings which are some what different from those followed in other states. The pertinent section of the law, which may be found in section 3289, Kentucky statutes, reads as follows:

"The common council shall divide said city into districts of not less than three nor more than nine, and as nearly equal in area and population as possible; and not less than one district shall be sewered at one time. The cost of sewering an entire district shall be apportioned among the property owners of said district ratably, according to the superficial area of said property owners' holdings in said sewer district."

Weston, West Virginia.

Weston is located on the West Fork River a branch of the Monongahela River about 30 miles south of Clarksburg, West Virginia. It is the county seat of Lewis County and the center of a community comprising farms, coal mines, and natural gas developments. The industrial development is small.

The population was reported as 5,700 by the 1920 federal census. It is estimated that the future population will reach 18,500 in 1970. This figure was used in estimating sewer capacities.

The drainage area of the West Fork River above Weston, including two small creeks entering at Weston, is 181 square miles. The water supply of Weston and also that for Clarksburg is taken from the West Fork River.

There are a number of existing sewers in Weston. There was no detailed information on record relative to these sewers at the time the investigation was made. A street superintendent who has constructed most of the sewers during the past 30 years carried the only record in his head.

The present sewers are built on the separate system. However many house connections have been made to the storm water sewers. Part of the present sewers empty into West Fork and others empty into each of the two creeks.

At present there is considerable pollution of the streams and there are many areas which have no sewers and have no outlet for sewers without further polluting the waterways.

The remedy suggested for Weston is to build main intercepting sewers along the river and the creek valleys which will carry the sewage to a pumping station and treatment plant just below the city. The treatment plant is to consist of settling tanks and sprinkling filters. The sewers were designed with a capacity of 300 gal. per capita for the estimated future population.

The cost of the entire project including main sewers, pumping station, and treatment plant was estimated at $154,000. Lateral sewers were not included for the reason that it is proposed to raise funds for the main sewers by a general bond issue while all lateral sewers have been built by local assessment. All lateral sewers will be 8 ins. and there will be no question of grade or proper location, as the ground rises rapidly away from the various water courses.

Rhinelander, Wis.

Rhinelander is the county seat of Oneida County, Wis. It is located on the Wisconsin River in the lake district of northern Wisconsin which makes it popular as a summer resort.

The largest industries are some paper mills. There are a number of smaller industries, many of which deal in wood products. The city is served by two railroads, the Chicago and Northwestern and the Soo Line.

The city was organized in 1894 and the population according to the United States census of 1920 was 6,654. It is estimated that there will be a population of 20,000 in 1960.

At present there are a considerable number of sewers of varying size and depth which extend quite generally over the city east of the Wisconsin River. West of the river and the areas in the southeasterly and northeasterly sections of the city there are comparatively few sewers.

The present sewers in most cases are of such size as to be characterized as sanitary or separate sewers. However, many of them have some excess capacity and are being used as combined sewers at present.

There is no condition of active nuisance through sewage disposal at present in Rhinelander. However, there is a need for new and relief sewers to eliminate the surcharging of existing sewers and to provide for the extension of sewers into districts which now have no sewers.

The general problem was to determine on a policy for sewer extension and to develop a general plan according to which new and relief sewers can be built. Provision for future intercepting sewers and sewage treatment was also included.

Except for a small section of the main business district where the present sewers are only large enough for combined sewers, the present sewers are only large enough for sanitary sewage. Also storm water can be carried to water courses or to a swamp area east of the city, with relatively short lengths of drains whereas it will be necessary to carry the domestic sewage long distances. The conditions make it advisable to provide separate sewers for domestic and storm sewage. Accordingly a comprehensive plan for sanitary sewers and another for storm sewers was prepared.

The general plans for sanitary and storm sewers were prepared and then cost estimates were made for tentative projects designated as desirable for present construction.

The additional sanitary sewers for extension into areas not now sewered were estimated to cost $95,800. The cost of the proposed relief sewers to carry storm or surface sewage only, was estimated at $45,000, including a drainage ditch through the swamp along the east side of the city.

Funds for the construction of the new work will probably be provided by a general bond issue which will require a general vote of the people of the city.

The foregoing matter is from a paper before the Iowa Engineering Society.

HOW TO EQUIP AND OPERATE LOCAL GRAVEL PITS TO PRODUCE CONCRETE AGGREGATE

By H. J. Kuelling, Construction Engineer, Wisconsin Highway Commission, Madison, Wis.

This subject may well be approached from one of two angles. First, from the viewpoint of the contractor who is to operate the pit, and, second, from the viewpoint of the engineer or public official who is to pass on the material. What the writer has to say will probably be a mixture of these two.

Many people view the subject of local material with suspicion. This is especially true of contractors who are not desirous of being loaded down with any more equipment or any more troubles. In Wisconsin, however, the contractors are gradually coming to look with favor upon this method of producing material, and there will be an ever increasing competition upon jobs where local material is available.

Economy Governs

In the opinion of the writer, the use or non-use of local material is entirely one of economy; in other words, the question of which is the cheaper, local or shipped in material. It is entirely out of the question for a state, county or local community to subsidize any commercial pit or quarry. The writer frankly admits that commercial pits and quarries can produce cheaper than a temporary local plant and advises using them where the question of freight does not enter and the difference in truck hauls is not too great. However, as soon as freight on a railway enters into the argument, the handicap of ninety cents to a dollar a yard enters, a sum which alone more than covers the average production cost of the Wisconsin local pits.

Local Commercial Production

Instead of the commercial companies sitting back and criticizing, the writer believes there is a good business opportunity for some of them to go into local production with one or more small outfits,

such as will be described below. Plenty of business could soon be worked up for such an enterprising producer, as many contractors with no experience in aggregate production would be only too glad to hitch up with him.

Some people criticize local material on the ground of quality. The good Lord doesn't change the sand and gravel if it is operated locally, rather than commercially. Properly operated, as many local pits are, just as good material is obtained in one case as the other. Assuming proper quality of sand and pebbles in the deposit, sufficient washing and separation of fine and coarse will produce satisfactory aggregates in either case. Improper operation will produce unsatisfactory material, as we all know who have had to reject material.

Local material may consist of the production of fine aggregate alone from a sand pit, the production of coarse aggregate alone from a local quarry, or the production of both fine and coarse aggregate from a gravel pit. The subject confines the writer to the last method, although all three are in operation in Wisconsin.

Wisconsin Production Data

During the past season in that State, there were constructed 355 miles of concrete road. Of these there were 187 miles on which the fine aggregates were shipped on a railway; 84 miles trucked or otherwise hauled directly from commercial plants; and 84 miles produced in local operations. In percentages these run 52.8 per cent shipped; 23.6 per cent trucked from commercial plants, and 23.6 per cent from local production.

In the matter of coarse aggregate there were 153 miles on which they were shipped on railways; 119 miles trucked from commercial plants, and 83 miles produced in local operations. In percentages these are 43.1 per cent shipped; 33.5 per cent trucked from commercial plants, and 23.4 per cent produced locally. Analyzing these on a basis of two coarse to one fine aggregate, it is readily seen that 54 per cent of the tonnage on these 355 miles of paving never saw a railway. Naturally this means cheaper concrete roads, a saving in freight, easing up on the burden of the railways, a saving in bond cost, and an easing up for the contractor in the all-important matter of financing his job.

This is mentioned to show the extreme importance of a thorough study of local materials where they exist. The writer is fully aware that many, in fact, a vast majority of communities, have no such opportunities to save money, but others have and are sometimes passing by a good opportunity, as we did in more than one case.

Locating and Testing Sites

A question of equal importance with the equipping and operating is the locating and proper testing of sites. There is no doubt that much of the ill repute of local production can be traced to lack of knowledge before operations were begun. Then when the pit failed the whole question of local production was condemned.

In Wisconsin we believe the matter of locating the gravel is the duty of a geologist, so all of our material parties are in charge of a geologist, just as they would be if we were to seek a deposit of lead or iron. His knowledge of geology shows him where to seek the best supplies. This has often been brought out in a startling manner in the finding of good pits where the local people insisted no material existed and where the average layman or engineer even would not suspect it. The duty of the engineer, who accompanies the geologist in locating, is to study the deposit from the physical viewpoint of whether or not it can be successfully operated.

Each party is equipped with a Ford ambulance of the type used in the World War. They are also fully equipped with shovels, picks, scales, containers, screens, glacial and soil maps, and any other tools necessary to conduct their work efficiently. Some of the parties carry along small cooking outfits while practically all of them sleep in their cars at night. They are paid a salary and have to maintain themselves out of this. They turn in an expense account for the car, however. Each party is given a number of proposed projects to cover.

The methods of each party vary, of course, with the kind of material for which they are searching. Those parties whose task it is to locate concrete aggregates have to spend more time and take more care in the results than do those parties who are locating surfacing materials.

Locating Aggregate for Concrete

A party locating aggregate for concrete construction must first try to locate a satisfactory deposit as near as possible to the center of the project. If this is impossible they must widen out in their search, always keeping in mind

the disadvantages of long hauls and poor setups. They must also locate in each case the nearest water supply and what it is. They usually do some test pitting, especially on undeveloped deposits, to determine stripping and otherwise prove their conclusions. In general, a field test is made of the material in the nature of a silt, colorimetric and screen test. Their notes are kept on loose leaf forms provided by the Highway Commission. The deposits are spotted by section, town and range, and the owners' names obtained wherever possible. Each deposit is given a location number, these numbers starting at one and running upward consecutively in each county; there being no duplicate numbers in any one county.

Such surveys cost the State in the neighborhood of $40 or $50 per mile of project. After the surveys are made and the field information properly analyzed, it is up to the materials department and the district office to see that the most promising locations are properly test pitted.

Test Pitting

The test pitting is an exceedingly important feature of the work. It must be done extensively and thoroughly. The methods involved and the extensiveness, of course, varies with the kind of material being searched for. If several miles of concrete road are to be built out of a proposed pit, it is necessary very thoroughly to test pit the site, especially if it is an undeveloped deposit. Enough holes should be dug to determine the extent and they should be dug to an adequate depth to determine the working face. We have dug holes 30 ft. and over by using box sheeting of 2-in. boards 4 ft. long dovetailed at the ends. It is an easy matter to construct a windlass operated by hand, and with a hole 4 ft. square a pretty good sized bucket can be attached for raising the material out of the opening. The samples for testing purposes should be taken at the time of digging. Our requirement for such purposes is a representative sample of 500 lbs. of pit run material from the deposit. The samples should not be taken from one hole but from several different holes. Probably the best method of handling the samples is to sack the material in cement sacks. Tags are filled out and one placed inside the sack and one attached after which they are sent express or freight collect to the laboratory at Madison. The man supervising the work also fills out an aggregate sheet furnished by the Commission describing the deposit, which sheet he sends direct to the materials department. Here a duplicate is made and sent to the laboratory and the original kept in the files.

From these samples tests are made, both on the fine aggregate and the coarse. Sand briquettes are made for breakage at three, seven, and ten days. Coarse aggregate is tested in specimens 18 ins. long, 8 ins. in width, and 4.3 ins. in thickness. These are always made at the same time as specimens of standard material. Both are tested at the same time in a rattler and later in tension and compression. By always running these tests with a standard, we not only compare the material with the standard, but with any other.

The information thus obtained is placed in the hands of prospective bidders through the medium of the district offices. The cost of testing material from one deposit is estimated to be about $35. If a prospective bidder is still not satisfied he may make an investigation of all the physical features surrounding its use, such as water supply, topography, soil, roads, etc.

Of course no proposed pit can be guaranteed to be absolutely safe. By this we mean, that even with the best kind of test pitting a few pits, where opened up, disclose objectionable features which were not apparent before. These features may be enumerated as a pit running to sand, too many oversize boulders, and a pit containing heavy seams of clay. These failures, however, are few and often where there has been a failure, some bit of negligence or ignorance was responsible for it.

Effects of Insufficient Test Pitting

For instance, in one case the proposed deposit was thoroughly test pitted, but in setting up the plant it was moved just a little north along the ridge from where the test holes had been. When the ridge was opened they encountered huge boulders and had to change the drag line to a steam shovel. The boulders had not shown up in test pitting and, in fact, the south side of the pit, which was the side nearest the test holes, showed hardly a boulder. Another case was that of a deposit not recommended by the state, but one which the contractor was eager to set up in. Consequently, while a small pit was showing in a ridge it was never thoroughly test pitted. This result was disastrous as the contractor was ordered

to shut down when it was found that the material was running out, and also was becoming too dirty to use for concrete. Another case was that of a perfectly good pit, but wherein inadequate machinery was placed. The contractor placed a small movable outfit in this pit to produce concrete aggregate. The bin capacity was only 18 yds. While the pit run material actually ran 50 per cent sand and 50 per cent stone, the plant was too small to handle the waste sand successfully, with the result that it was an absolute failure and was forced to quit right at the start.

The writer has gone into all this detail of locating and testing gravel pits thoroughly to impress the fact that local production requires considerable gray matter before one should think of the equipment and operation.

Production of Concrete Aggregates

The production of concrete aggregates by means of a local plant is a problem of some magnitude. In the first place, let it be said that a plant for this purpose must be stationary. There is no such thing as an efficient portable plant for producing concrete aggregate. Another adequate bin capacity, for if there happens to be a temporary breakdown in the pit operating machinery and the bins are pretty well filled up, the trucks or other hauling equipment is still able to operate. Of course, the entire equipment must be efficient and efficiently operated as well. Too small a crusher or screens, not enough horsepower, poor management, and a poor pump in case of washing, are some of the objectionable factors in a plant not operating efficiently. The contractor in choosing his set-up and machinery has quite a problem on his hands. He should look the proposed site over well and take all the factors into consideration. He must consider the distance he is to be from the project and also what method of hauling and charging the mixer is to be used. Of course, the problem of set-up does not always rest with the contractor, as there are quite a number of cases where the county has owned and operated a pit, supplying material for its own day labor crew, or else furnishing material to a contractor at a much lower price than he could purchase it from a commercial concern.

Plant Costs

A well built and efficient gravel plant for producing satisfactory aggregates for concrete pavement construction should cost in the neighborhood of $10,000 to $12,000, including the items of erection. The reason for a variance between the above mentioned figures, is the difference in cost between a washing and dry screening plant, freight, erection, etc. A plant of this price has a bin capacity of about 200 yds., which ought to be sufficient. Below is a table showing the approximate cost of a stationary up-to-date gravel plant:

Crusher	$ 2,800
Grizzly screen	50
Blade Feeder	300
Cables, shieves, etc.	300
Hoist	1,000
Drag line bucket	450
Two 60-h.p. motors	2,200
Elevator	500
Screens	400
Lumber for bins, etc.	1,000
Cost of erection	1,000
	$10,000
Cost of washing equipment	700

Another item which is really an extra is the measuring device. Where batch trucks, for instance, are to be used this is an absolute necessity. There have been attempts to construct home-made devices with mediocre success. There are mechanical devices on the market which are quite successful. They are, however, pretty expensive, as an outfit costs about $500.

Description of Good Plant

Two plants of one contractor are identically alike, and while not absolute models of perfection are worthy of description. An arrow-shaped drag line bucket handling about a cubic yard at a time pulls the material up, where it is dumped through a trap onto the blade feeder. This feeder is in the form of an endless belt which has a number of blades fastened thereon. This turns slowly and constantly dumps the material onto the grizzly screen. Thus the material is fed gradually to the crusher while the drag line is making its return trip. The rejected gravel from the grizzly drops into a No. 4 gyratory crusher set at about 1½ ins. Then the material is carried up to the screens in a bucket elevator about 50 ft. high and containing approximately 140 buckets. The screens are of the revolving type, 4 ft. in diameter and in sections. The first section is 6 ft. with a ¼-in. round opening; the second, 4 ft. with ¼-in. round opening, and the third 6 ft. with elliptical opening ¼-in. by 1 in. in size. For dry screening a screen of the last section type is probably the best. However, the last section of screen should have 2-in. round openings to take care of any oversize material. A chute could be built from the end of this screen

back to the crusher. It has also been found very necessary at times to insert a section of ½-in. round screen to waste the pea gravel sizes when the gravel in the deposit runs fine. Two 60 HP motors furnish the power for operating this plant. One takes care of the blade feeder, crusher, elevator and screens, and the other the double drum hoist operating the drag line.

The bins for this plant are 11 ft. wide, 36 ft. long, and 14 ft. deep. They are set on a concrete foundation 38 ft. long with a base of 3 ft. and tapering up to 16 ins. The horizontal timbers resting on this concrete foundation and supporting the uprights are 10-ins. by 12 ins. The uprights themselves are 10-ins. by 10-ins. and 12-ins. by 12-ins. Seven 10-in. by 12-in. timbers are used as braces for the uprights. There are also 14 cross braces 6-ins. by 8-ins. in size, seven on each side; 2-in. by 12-in. pieces are used as floor joists spaced with 6-in. centers. There is also 3x12-in. cross bracing on the side, two being used together making six pairs on each side. The floor and sides of the bins are of 2x12-in. planks, the studding being the same size as the floor joists. They are double rodded, the long rods being 1½ ins. in diameter and the short ones 1⅛ ins. The bin supports or wales through which the rods are bolted are 6x12-ins. doubled. These hold the whole bin together and there are three tiers of them, the first 1 ft. above the sill, the second 4 ft., and the third 10 ft.

Sand Washing

A large proportion of local pits contain enough dirty material to require washing. There is also something in the proposition of expediting the work of the screens by washing, especially on damp days. A number of different types of washers are used. Probably the most common is that of old tilting box type, with which nearly everyone is familiar. The valve control or discharge for the washed sand in this type is dependent of operation upon the weight of the sand contained in the settling tank. There are a few mechanical objections to a washer such as this. First, the inertia of so great a weight makes the valve action slow, so that with uneven feeds the valve does not always close in time to prevent a "runaway". Secondly, a tank of this sort is operated by balanced weights which to operate quickly must be set so that the valve does not close tightly when the feed of sand ceases but while the water is still coming. Sometimes, unless the valve is closed by hand, an amount of water and clay gets into the clean sand already discharged.

There are also steel conical tanks on the market which are quite expensive, but more efficient as the discharge is controlled by volume rather than by weight.

A good many pit operators are using a washer of a different type. This is really a mechanical conveyor sort of settling tank. It consists of a large rectangular wash box of wood, with a discharge for clay and dirty water at one end. The floor of this box slopes upward at the other end to the top. A number of blades are fastened to an endless chain which operates over sprocket gears at either end of the box. These blades dip down into the water, and by close contact with the slanting floor carry the washed sand to the top where it is dumped over into the bins. There is a space at either end of each blade, which permits excess water to return to the tank. These blades continually agitate the dirty water in the tank and keep the dirt in suspension until it is carried off over the spillway. Plenty of clean water must be poured into the tank continually, and it is well to have several sprinklers playing on material as it is pulled up to be dumped into the bins. These washers are sold in two sizes, 4x18-ft., and 3x18-ft., respectively, and are priced at about $500, exclusive of any wash box lumber. The former size has a capacity of 40 tons of sand per hour and the latter 35 tons.

Gravel Washing

Any of these washers, of course, are for sand only. It is sometimes and, in fact, always, just as necessary to cleanse the gravel. For this a water pipe with an end spray can be discharged into the screens. This will aid very materially in pushing the sand through the sand screen into the settling tank, and also for separating the sand from the stone, when it has a tendency to stick together in damp weather. It is also advantageous to have a section of closed screen containing angle irons bolted to the sides, which may be termed a scrubbing chamber. One of the principal requisites for a successful washing plant is plenty of clean water. Four-inch pipe should be used, if possible, and a pump powerful enough and an adequate water supply to produce 250 to 300 gals. a minute, is necessary.

Cost and Production Data

From one pit about 6.53 miles were built. The total job was 7.29 miles in length or 77,176.4 sq. yds. of paving. The low bid on this was $1.07 per sq. yd., exclusive of cement, as against the lowest price bid for commercial material of between $1.12 and $1.16. This is a difference of about 7 cts. per sq. yd., or a total saving of $5,402.35 on the entire job. However, the facts that the pit was easily obtainable and a good set-up, that the hauls were good, and that several contractors were interested who wished to go into their own material production, all had a tendency toward producing one of the lowest bids per square yard in the whole state.

Another job consisted of about 8 miles of 18-ft. paving, the low bid being $1.19 per sq. yd., and the lowest bid per square yard using commercial material was $1.49, or a saving of 30 cts. per sq. yd. This meant a saving of approximately $25,344 on this one job. The plant was equipped with a hoist and upright boiler, arrow scraper, one 60-HP motor, a loader elevator, a bucket elevator, old style washing plant, screens and 160-yd. capacity bins. Provision was made to shoot the rejected oversize stone back into the pit. From this plant approximately 25,400 cu. yds. of sand and gravel were hauled out on the road. This meant an average of about 250 yds. a day on the road and does not include an average of about 20 to 25 yds. of material wasted each day. Material was hauled in trucks onto the road and stock piled every thousand feet. From the stockpiles a fleet of Ford batch trucks carried the aggregate to the mixer.

Another road, 3.3 miles in length, was constructed, the low bid being $1.29 per sq. yd., using local material. The lowest price bid per square yard using commercial material was $1.45, a saving of 16 cts. per sq. yd. This means a saving of $5,575.68 on the entire job. The material was trucked onto the roadbed, stockpiled and wheelbarrows used to charge the mixer. This was the second season that the contractor had operated this pit.

Another job of 4 miles was partly constructed, about 3½ miles being built. The bid per square yard using local material, was $1.11, whereas the lowest bid per yard using commercial material was $1.35, or a saving of 25 cts. a sq. yd. This is a saving of $10,137.60 for the entire job. The material was hauled on the road, stockpiled, and wheelbarrows used to charge the mixer. They had about 6,000 yds. of material stockpiled on the subgrade before the actual paving work started. The equipment at the pit consisted of a bottomless drag line bucket, a plate feeder, a conveyor, a 9x15-in. jaw crusher, grizzly, a 36-ft. bucket elevator, a tilting box type washer, screens and bins, a 60-HP. tractor, a double drum hoist and upright boiler, a 10-20 tractor, and a centrifugal pump. The bin capacity was small, holding only 90 to 100 cu. yds. Provision was made to shoot the oversize stone back to the crusher. The 10-20 tractor furnished power for the pump which had a capacity of 450 gals. a minute, but only about 300 gals. a minute were actually used. The production of this plant was small as it averaged only about 150 cu. yds. of sand and stone to the road per day. The smallness of the crusher was greatly to blame for this as the 9x15-in. jaw crusher was only capable of a capacity of about 10 to 15 cu. yds. an hour. What they should have had in its place was a gyratory crusher No. 3 or 4 in size. The bin capacity was small and the whole plant was not constructed in as stable a manner as possible, probably accounting for the numerous delays and breakdowns. It seems true also from various observations that a scraper of the arrow type will handle a larger amount of material than the bottomless bucket.

One county operated two local plants. One contractor built about 40,634 sq. yds., using material from one of the county pits. His price for this of $1.16 per sq. yd. was based on material at $1 per cu. yd. in trucks at the pit. This material, had he shipped it in, would have cost him $2.18 per cu. yd. for gravel and $1.90 per cu. yd. for sand in trucks at the destination. The comparative hauls were about the same.

The other county pit kept two pavers going, and about 8 miles of road were built using this material. It is rather difficult to get at the saving involved here as the contractor's bid did not include a material price, this being furnished him by the county. The county highway commissioner, however, believes that material was being produced in stockpiles for about 70 cts. a yd. Shipped in sand and stone would have cost $2.03 and $2.20 per yd. respectively, unloaded in stockpiles or bins. As in the neighbor-

hood of 26,000 cu. yds. of sand and stone were used in building the road, it will be seen that considerable saving was involved (at least $30,000) by developing a local pit.

Both of these county plants used wash boxes. Each plant was equipped with a stiff leg derrick and bucket. The material as it came from the screens, was loaded into a large stockpile. From here it was transferred into the big measuring hoppers and loaded into batch trucks.

It will be noted in most of the cases cited above that competitive bids were asked on local and commercial materials. This was done on practically all the early jobs to have figures for comparison. The longer in advance the preliminary information is obtained, the better, providing of course, the locations are properly protected by options so that no individual can corner the supply. The contractor or county which is to operate the pit should determine the output desired, the amount of crushing likely to be required, and the amount of water needed before designing the equipment to be installed.

Advantages to Contractor

While the production of local materials may add somewhat to a contractor's troubles, it also has its redeeming features. He ceases to worry about gondolas, freight trains, train crews, paying for water in sand and gravel, demurrage, and kindred other pleasant things. He has his work more concentrated and can handle his paving crew more efficiently as he knows more accurately the delivery of aggregates than where dependent upon a railway.

In conclusion, the writer fully realizes that the use of local materials is a highly localized matter, but he also believes that where local material exists, the subject is deserving of the very best engineering and contracting talent that can be given it.

With us it has not only been the question of money savings. It has enabled us to do work which could not otherwise be done, as it has relieved the railroads of business which they could not have handled, and left equipment free for those jobs which absolutely had to be handled by rail.

The foregoing paper by Mr. Kuelling was presented at the recent annual meeting of the American Road Builders Association.

THE VALUE OF COMPREHENSIVE WATER SUPPLY INVESTIGATIONS

By Alex Van Praag, Jr., of Holbrook, Warren & Van Praag, Consulting Engineers, Millikin Bldg., Decatur, Ill.

Perhaps no one element is more directly responsible for the uneconomical operation and high maintenance costs, and the ultimate failure and abandonment of municipal water works stations than the failure to conduct a comprehensive and systematic study of the community's water resources prior to the construction of the water works system. By a comprehensive and systematic study of the community's water resources is meant a thorough knowledge of the available sources for a water supply development, together with a reasonable understanding of the possibilities of the chosen source of supply with respect to future extensions and enlargement; and also a complete analysis of the relative costs of developing the available sources of water supply, including operation and maintenance costs. The object of this paper is to discuss the value of such preliminary studies insofar as they apply to shallow ground water sources.

Abandonment of Sources of Supply

That an accusation of this character is based upon sound facts and is just, is evidenced by the substantial number of municipalities which from time to time entirely abandon one source of supply in favor of a newly located source, not infrequently in close proximity to the original or former source of supply.

Influence of Local Conditions

It is manifest, if the above mentioned preliminary studies are to be made, that one of the first and most vital determinations in the study is an assembly of the facts concerning the water bearing strata. Now, throughout certain sections of Illinois the nature of the geological structure is relatively well known and the records thereof are reasonably complete. For example, in most of our northern counties it is reasonably certain that an ample water supply of good quality is readily obtainable if wells are drilled to St. Peter or Potsdam standstone. In such a case a preliminary study requires no extensive prospective or test drillings to determine the local geological structure, but may be considered primarily, if not solely, for the purpose of ascertaining the type and probable cost of any proposed installation.

In other sections of Illinois, however,

the prevailing conditions are decidedly different. In central Illinois, for example, the major number of our public water supplies are derived from shallow ground sources, more generally from water bearing glacial drift deposits. The records of drillings in one community are of little if any value to a neighboring community, and in general the records themselves are very meager. Moreover, the glacial drift is peculiarly irregular and non-homogeneous and there is no certainty in securing any appreciable volume of water until extended drillings and extensive pumping tests have been made. Under these conditions the preliminary studies in connection with a proposed water supply installation are of grave importance, for on their thoroughness not only depends the possibility of the installation from a financial standpoint, but also the feasibility of any installation being made at all. Still further, the reliability and operating success and the cost of maintenance in such cases is entirely dependent upon the action taken as a result of the preliminary investigation.

All too frequently preliminary investigations of ground water supplies are not made at all or they are directed by the unqualified judgment of local persons in preference to being based upon an assembly and study of facts and data best interpreted by engineers experienced in water supply developments. It seems to be the general, mistaken impression of public officials that the first available funds should be expended at once for a part of the necessary equipment for the water works instead of using the first modest expenditure for investigation to insure the water works installation being a permanent and economical one.

Mt. Pulaski, Ill., as an Example

In order to elaborate somewhat on the necessity of preliminary studies and suitable test drillings the author assumes the liberty of referring to, and analyzing, the water supply history of a particular city with which he is personally familiar. It is one which presents a typical case.

Mt. Pulaski, Ill., is a city of 1,510 population. It is built upon the peak of an abrupt hill, one of a few high points in central Illinois. The surrounding territory is quite flat and the nearest well defined watercourse is approximately 3½ miles distant.

The original water works at Mt. Pulaski were installed in 1895 and the source of supply then comprised a single well about 85 ft. in depth, penetrating fine sand, and located at the public square on the very peak of the hill. About 1907, only twelve years later, a new water works station was constructed in the southwest part of the city, the supply then being derived from three dug wells, penetrating a layer of fine yellow sand of more or less indefinite depth. Each well was 33 ft. in depth and was walled with stone. These three wells which are still in service are all located on a single tract of land enclosing about ¾ of an acre. Another similar well but with a 23 ft. tubular extension in its bottom was also located nearby and formerly was held in reserve to meet excessive demands though it later was entirely discarded as a part of the public water supply.

Since their construction these wells have ever been subject to clogging with fine sand, thereby reducing their capacities, causing undue wear on pumping equipment, and resulting in exorbitant maintenance costs. Their yields have accordingly been totally inadequate and the cause of a general restricted use of water. The restricted use of water has resulted in a general tendency to depend upon private wells, all of which circumstances of course, assist in raising the unit operating costs of the public supply.

For some time the city council has realized the necessity of improving the city's water supply resources and during the past year it was prevailed upon by its engineers to conduct a series of test drillings in the hopes of locating a more satisfactory source of supply.

The engineers outlined a systematic program of drilling based upon a study of the surrounding topography, assembled records of previous drillings, and a knowledge of the general geological structure in the vicinity, and the drilling program was instituted.

A series of holes were drilled progressively to the east and south along a more or less meandering line lying just south of the city, where the available data indicated a satisfactory supply was most likely to be located. As each test well was drilled samples of the drillings were collected for examination and accurate logs of the wells were drawn. The logs were platted in section to their true elevation along sections drawn through the principal lines of the drill holes, and an accurate plat was made showing the location of each test hole. This data not only served its purpose during the progress of the drillings but is now a matter of permanent record.

A total of 22 test holes were drilled be-

fore a supply of satisfactory volume was located and the final location determined for a new pumping station. As a result of the drillings, however, the city has located a water bearing strata consisting of coarse sand and clean coarse blue gravel approximately 17.5 ft. in depth and lying between depths of 40 and 57.5 ft. below the surface. The deposit is under a static head of water which rises to within 14 ft. of the surface.

Before concluding the test drillings the city conducted a pumping test on an 8 in. well located at the site of one of the test drillings. The test was conducted under the direction of the engineers assisted by representatives of the Illinois State Water Survey and the State Department of Public Health. It included a continuous pumping of the well for 26 hours, more or less, during which time measurements of the well discharge and of the draw-down both at the well itself and at other nearby points were simultaneously recorded. It should be noted that while the draw-down when first pumping the well was marked and rapid, yet with continued pumping the water level gradually assumed a more or less permanent level and at no time was it lowered to the top of the water bearing strata.

The test data secured indicates that the city can produce from a single well in the vicinity a sufficient supply of water to satisfy its present demand with less than six hours of continuous pumping. Heretofore the present wells have been exhausted after a relatively short period of pumping, and it became necessary to discontinue pumping until they again were replenished, and the supply accordingly has been extremely doubtful at all times.

The total cost to the city for conducting the test drillings approximated $1,500 and the city is now having prepared the necessary plans and specifications for a new pumping station. This new pumping station will probably be constructed during the coming year. It makes the third water pumping station to be constructed in a period of 28 years. It is 16 years since the construction of the present station.

It should not be assumed that the Mt. Pulaski situation is an unusual one and that it did not offer its difficulties all during the period of the drilling. As a matter of fact it was necessary at the outset, in order to satisfy certain members of the city council, to drill two holes on the present pumping station lot. Both of these holes were drilled to more than twice the depth of the present dug wells and each penetrated but a negligible depth of fine yellow sand, water bearing, and thus showed conclusively that the present location is a most unsatisfactory one.

Again, after sinking some 7 or 8 holes with only moderate success the city, against the advice of its engineers, again returned to the present water works site and sunk in the immediate vicinity at least two more holes.

Also during the course of the drilling it was necessary to satisfy the demands of certain council members who have a religious belief in the unfailing "water witch." These particular members, it is interesting to note, were able by the use of the "witch" to trace the water bearing strata from one of the test hole locations, after the test hole had been drilled, for a distance of nearly 150 ft. towards the old pumping station site. At this point they were forced to discontinue the use of the "witch" because of severe cold weather and unfortunately the weather has not as yet sufficiently moderated to permit their again bringing out the "witch" for further service.

Now it should be noted also that at Mt. Pulaski there were no visible or outstanding assurances of success in locating a satisfactory water supply if the test holes were sunk excepting the convictions of the engineers who had devoted some time and study to the local situation. To be sure, many of the first holes sunk indicated discouraging results and it was not until the entire 22 holes were sunk that conditions were considered satisfactory to warrant discontinuing further investigations. On the other hand in a similar study at Witt, Illinois, it was found necessary to sink but 5 holes when sufficient data was secured to warrant discontinuing drilling.

Now it is not of general interest that Mt. Pulaski has experienced particular success in improving its water supply by drilling. The Mt. Pulaski experience is discussed herein because it embraces a typical experience and illustrates the one point the author wished to impress, and that is this, by a modest expenditure for test drillings and preliminary investigations and by truly studying and investigating its water supply resources this city has located a source of water supply sufficient to warrant the abandonment of its present supply in favor of a new one. This new supply was only recently investigated, but had it been properly investigated before the preceding two water pumping stations were installed it would doubtless have made unnecessary the very large expenditure for rebuilding at least

twice, and also it would have eliminated very largely the relatively exorbitant maintenance costs which have been experienced by the city for the past 28 years. Many other cities have had much the same history as Mt. Pulaski; and not until the value of thorough preliminary studies is fully appreciated can we expect to eliminate this needless waste of money on water work improvements.

As engineers or persons otherwise interested in the proper development of public water supplies it remains with us to exert every effort to make sure that future water supply installations will be made based upon sound facts and not upon chance judgment. In other words, if we wish to insure proper and economical water supply installations, and assist in preventing expensive rebuilding programs, we must impress the responsible officials with the necessity of comprehensive and systematic preliminary water supply investigations directed by competent engineers. By such means only can we prevent the continued recurrence of experiences such as those of Mt. Pulaski.

The foregoing paper was presented at the recent annual meeting of the Illinois Section of the American Water Works Association.

MAINTENANCE OF MACADAM ROADS WITH BITUMINOUS MATERIALS

By H. S. Perry, Assistant Chief Engineer of Maintenance, Ohio Department of Highways, Columbus, Ohio.

The maintenance of macadam roads is about the biggest problem in road maintenance in Ohio as well as in many of the eastern states. At the end of 1921 there were 1,153 miles of waterbound macadam and 624 miles of penetration macadam under state supervision in Ohio, representing 47 percent of the State improved mileage. On the surface only of this mileage there was spent a total of $2,393,500, representing 40.5 percent of the expenditures of the Bureau of Maintenance for that year. The surface maintenance of waterbound macadam represents about $1,600,000 of this, or $1,375 per mile of surface, the average width for the entire State being about 15 ft.; bituminous macadam maintenance represents about $800,000 of this, or $1,285 per mile of surface averaging 16 ft. in width. It is necessary to qualify the above figures with the remark that the waterbound figures include 95 miles of resurfacing at a cost of about $800,000 and that the bituminous macadam figure includes 40 miles of resurfacing at a cost of about $475,000. The plain maintenance figures therefore for 1921 were about $760 per mile for waterbound and about $590 per mile for bituminous macadam.

Surface Patching

There is no end to the manner and method of repairing the surface of a macadam road, the variations in manner ranging from the experimental to the expert, and in method depending on the materials used.

(a) The paint patch will be first discussed. The original purpose of the paint patch was to cover up a barren spot on the surface where the surface treatment had worn off. We have broadened this in Ohio to a point where quite a heavy patch can be made by painting. In making a skin paint patch it is desirable to use a fairly light bituminous material—such as medium tar (with a viscosity of about 30). Tar or asphalt cut back make satisfactory light paint patches—better in fact than medium tar, but are much more expensive. We are following the State of Pennsylvania in developing a cold asphalt by fluxing back a hot asphalt with naphtha, principally for surface treatments; but it will in all probability be a satisfactory material to use in paint patching. It is not out of place here to emphasize the extreme desirability of not using too great a number of bituminous materials in maintenance work. As a class the labor units do not make a very great pretense at brain work and therefore are likely to become confused with too much to remember. Local conditions should always be used as a guide in determining the number of different kinds of bituminous materials. If there is but a small volume of work, tar or asphalt cut back, which can be used for practically all kinds of surface patching, should be purchased, perhaps to the exclusion of any other material.

Skin Paint Patch

In preparing the surface for a skin paint patch, it is only necessary that the surface be clean and quite dry, inasmuch as this work presupposes a previous surface treatment. During the major portion of the working season the materials mentioned above are sufficiently fluid to omit heating. Heating, however, is of value, especially with the cut backs, and with all materials in cool weather, in that it assists in drying the surface and assists the laborers in a more uniform applica-

tion and increases adhesion with covering. The surface should be covered liberally with the bituminous material used, at least in a quantity that will equal or slightly exceed the amount of bituminous materials on the adjacent surface. For a covering in this case considerable latitude obtains. It is not necessary that the covering be dry, although a better job will result, if dry. Gravel, crushed or round, slag, limestone, igneous rocks, crushed and of good quality, and of size one-tenth inch to three-quarter inch, depending on availability, may be used. An ample supply should be used, since traffic will whip off a considerable amount. If it is apparent that a rainfall is imminent, work of this nature might well be delayed; it is highly desirable that one day's dry weather follow it up, to expedite setting. This kind of patching gives variable results, depending on dryness, cleanness, traffic, subsequent weather, etc., and should be followed up with subsequent bituminous protection.

Heavy Paint Patch

The heavy paint patch has grown considerably in my favor during the past two years and in my opinion bids fair to entirely supplant any kind of thin cold mix patching. In the construction of this heavy paint patch but one bituminous material is being used. This is hot tar, a heavy tar requiring heating at all times, and approaching penetration tar in its float test requirements. This patch is to be used to remove depressional areas, chatter bump dips, and to build up slightly low edges. Also in the prevention of slipperiness on treated macadam surfaces I know of no better method than the use of the hot tar paint patch. In my opinion it is necessary to carry on this latter method by hand, since only in this way can an ample supply of screenings be incorporated into the surface. If a distributor operation is attempted, there will be too great a cooling of the bituminous material and too complete a covering of the screenings with tar, thus destroying the mosaic surface that would otherwise be produced by hand. The same principles apply in the construction of this as with the skin paint patch. As a covering a hard crushed material is necessary, of a size one-quarter to one inch, varying the size of the material with the requirements. As a preventive of slipperiness on grades, a covering approaching the upper limits would probably be preferable. Volume of traffic would also be an influencing factor here as elsewhere, the greater volume warranting a coarser material. It is my opinion that, generally speaking, for maintenance as well as for construction, the tendency has been to use entirely too small sized stone.

The same things hold true in the use of bituminous materials in surface maintenance. The general tendency seems to be toward the substitution of a heavier material for a lighter material of the same base for a particular grade of work. This is especially true where such change would tend to reduce the number of bituminous materials used. During the past two years the Ohio specifications have dropped 3, and now carry 16, of which 7 are asphalt and 9 tar.

Cold Mix Patch

(b) Next comes the subject of the cold mix patch. This includes asphalt emulsion, rock asphalt, and cut back (tar or asphalt). We have not seen fit to develop the use of asphalt emulsion, due to price and to the fact that it is injured by freezing, due to its water content. It has other minor objections, but is a highly satisfactory material. The use of rock asphalt as a cold patch material in Ohio has shown that it is a remarkable material. It is excellent in pot holes and in the repaving of sections of sheet asphalt and asphaltic concrete, in that the sole equipment required is a roller, together with minor tools, of course. This material relieves one of the necessity of using a hot mix plant for sheet maintenance and in this respect is very satisfactory. A compaction of one-third must be allowed for.

Cut Back Patch

The cut back patch has been developed very extensively in Ohio, both asphalt and tar being used. It is adapted to wide usage; and its abuse is about in proportion. There are several variable conditions that determine whether or not this patch is to be successful. The quality of the bituminous material, the moisture content of the aggregate, the quality, shape, and sizing of the aggregate, the proportion of the mix, the care in placing, and the subsequent attention to prevent raveling, are the chief elements. We have gradually varied the quality of both asphalt and tar cut back, so that we now have fairly satisfactory materials. I believe, however, that a further increase in the viscosity of tar, say ten points to 50-70, would improve it. A very great source of trouble arises in the second element: moisture content of the aggregate. I have frequently observed the curing mix covered with tarpaulins and

the untreated left unprotected; not that it is all advised to protect the curing mix; it is much more important, however, that the untreated aggregate be kept dry. We have during the past two years constructed a number of mixing sheds. These sheds are primarily designed for the purpose of guaranteeing a dry aggregate. They also provide quarters in which to carry on this work in inclement weather and are giving excellent satisfaction.

Good cut back patching cannot be secured unless the aggregate is absolutely dry. The quality and sizing of the aggregate are of importance. Inasmuch as the resultant product is worth $8 to $10 per ton, this fact alone should warrant the use of a hard and tough aggregate. None but a crushed material should be used, since rounded material tends to induce waving. We have found it desirable to use two sizes: three-quarters to one-quarter, and one-half to one-tenth. In a great many cases a mixture of these sizes, about two-thirds of the coarser and one-third of the finer, have proved very satisfactory. Occasionally a coarser aggregate has been used; but generally when this is the case a penetration patch is to be preferred. The aggregate should be free from dust, since dust prevents the proper coating of the aggregate. Some authorities use sand as a part of the aggregate; but sand seems to have the same objections as dust; besides its use brings in another variable factor, and its use is not necessary to secure density. (Traffic will take care of this item.)

The proportions of the mix deserve special consideration. Too frequently the laborer will hazard a guess as to "how much is a shovelful?" It is very important to know exactly how much of aggregate and how much of bituminous material is used. If the hand mixing method is used, a bucket should be the unit, and not a shovelful. If a mixing machine is used, let a line be marked on the skip at a point determined by a definite number of bucketfuls, and let this line be carefully observed. If mixed by hand, the aggregate should be spread out on a platform ample in width for two men to work opposite, and the bituminous material spread over the aggregate. This should be turned seven or eight times, at least, until all the aggregate is coated. Neither the earth nor the surface of the road should be used as a mixing platform; the earth being a wasteful place, and the surface of the road dangerous. If mixed by machine, the drum should not be over two-thirds full when running, and the batch should be mixed three minutes. The mixer should be cleaned with kerosene daily when in use.

The proportions vary with the method, more bituminous material being required by hand than by machine, and more being required when a poorly graded aggregate is used than when a well-graded aggregate is used. An excess of fines requires more bituminous material, as does also a porous aggregate, especially slag, which should not be used in cut back, if it is possible to avoid it. In general a well-graded aggregate mixed by hand should require by volume one part tar or asphalt cut back to twelve parts aggregate; by machine add one-half to one part aggregate. If slag is used it is almost imperative that the mixing be done twice, using 1 to 12 or 13 during the first mixing; and after an interval of one or two days, permitting the absorption of the bituminous materials, remix, using about one-third more bituminous material. Let it be remembered that a successful mix requires bone-dry aggregate. The care in placing the cut back is an item that deserves its consideration from the standpoint of aesthetics as well as durability. Those placing the cut back should carefully follow the depression, remembering to lay the patch slightly high, carefully raking and smoothing the surface with a shovel (square pointed) and tamping the surface uniformly with a steel 8x8-in. tamper. Remember that it is easier to build up a low patch than to chop off a high patch, and do not worry about whether the first patch placed is going to iron out just right under traffic. In tamping do not cover the patch with clean stone to prevent sticking to the tamper. A little kerosene on the tamper on occasion will take care of this annoyance. Before placing the cut back the surface of the road to be patched must be painted. Let the painting extend in annular rings, 6 to 8 ins. around the entire cut back area.

The most desirable material to use is heated hot tar or heated cut back. Be careful in heating cut back, as it is quite inflammable. Use nothing less than a 2-barrel (110-gal.) kettle, so that the entire contents of one barrel can be deposited in it at one time. This painting will require about one-third to four-tenths gallon per square yard. Be careful to prevent the formation of pools in low spots in the surface. After the completion of the cut back patch, cover the marginal 6 to 8-in.

space with untreated ¾ to ¼-in. stone. This will serve the double purpose of easing off the patch and protecting the edge. Under no circumstances should it be omitted. In case the cut back patch reaches to the edge of the metal, the further precaution should be taken to keep the edge true to line. It is good economy to use two by fours flat as marginal forms. The cut back along the edge must be carefully tamped vertically before the forms are removed and at an angle of 45 deg. immediately after their removal. Let this tamping be done carefully, as the initial failure of an edge patch usually takes place at the edge and can be prevented by careful attention.

And last in the care of a cut back patch comes the question of subsequent attention. Regardless of careless proportioning and moist stone, careful maintenance can keep a patch of this kind from raveling. It must not be neglected, whether traffic be heavy or light. Heavy traffic will iron the patch down, but it will also cause it to ravel. Light traffic will not iron it sufficiently to prevent its weathering. Immediately on the first evidence of raveling, the patch must be painted, using a fairly heavy material. Medium tar will not prove satisfactory, as it is absorbed too readily, and the quantity required would be so excessive as to soften the patch. Use either hot tar or cut back, either sufficiently heated to be spread readily in a uniform coating.

As an evidence of the virtue of this subsequent maintenance, I would like to observe that our Eastern Division on 50 miles of the National Road, consisting principally of brick, has done a great amount of cut back patching during the past year and to my knowledge has not lost one patch. Cut back patching on brick is most difficult, and success in this case I attribute largely to painting the patch on initial raveling. I am quite willing to state as my conviction that if the above considerations are all carefully followed there will be very few failures in the use of the cut back patch.

Penetration Patch

(c) The use of the penetration patch is more or less limited. Some say that they can make this patch stick; and that they therefore use it always. This should not be the case. As a general rule there should be no trouble making the penetration patch stick. Its chief objection consists in getting a rough job, because a thin patch can hardly be made in this manner. This patch should be used only where the place to be patched is about 3 or 4 ins. deep. Stone 1½ to 2½ ins. in size should be used and the patch made after the manner of a construction job.

Penetration tar or asphalt should be used and in the proportion of about 1 gal. per sq. yd. per in. depth. Preceding the application of the bituminous material the stone should be rolled with a 10-ton roller, taking care that on a large patch the proper cross sections be secured by the proper addition or removal of stone and re-rolling. Let the screenings be clean (¾ to ¼-in.) and spread by longitudinal casting and not transverse. This latter method of casting from the edge over toward the center is very likely to leave ridges in the patch that no amount of rolling can eliminate. In case the patch is small, it is best to see that it is built just a trifle low and later built up by cut back or paint patching or both. A penetration patch should never be attempted without the use of a road roller, whereas a cut back patch does not require a roller unless traffic be light, or the patch very extensive, and in this case the use of the roller is justified for the sake of speed. If the penetration work is not very extensive, the use of tar would likely be preferable, due to the fact that it requires less heating. If the volume of this work is large, requiring tank car usage, either tar or asphalt might be used, depending on the price applied.

Repairing Breaks in Waterbound Road

(d) We have had frequent breaks clear through the surface of a waterbound road, with no roller to use in their repair. The customary method followed with excellent results has been to dig out the failed portions and tamp in coarse stone in layers by hand until the hole is brought up about flush, filling with fine screenings dry tamped. Then the surface is amply covered with screenings kept in position daily under traffic for a week or two, depending on traffic, until pretty well compacted. It is then cleaned thoroughly, painted and brought up with cut back and paint patching several times until there is no more settlement. The secret of success in a patch of this or any other kind consists in getting results that traffic will not shy away from, the answer being that one must secure a uniform easy riding patch of the same color and appearance as the rest of the surface.

I might note that our waterbound surfaces are all maintained by bituminous treatments and that traffic naturally shies from one of these traffic bound spots be-

fore it is surface patched. The result is that during the first day after it is surface patched it goes down very decidedly, due to the fact that traffic is no longer afraid of it. I mention this as a trifling incident; it is, however, an illustration of one of the requirements of good patching taking into consideration the psychological effect of the appearance of a patch on the automobile driver. Many a driver will shy from an unsightly patch just as he would from a hole, even though the patch be substantial. The first lesson for a laborer to learn in making a patch is neatness; the second, accurate observation of his and others' previous work. Experience is of course the teacher, but one possessing these two qualifications is almost sure to develop into a good man.

Surface Treatments

The purpose of a surface treatment should be two-fold: It should waterproof the surface and it should offset surface abrasion. In some quarters it is the belief that the treatment should be merely a waterproofing of the surface, and consequently an annual treatment of a light-bodied material is applied. There can be no question, it seems to me, but that this only partly takes care of the problem of macadam maintenance. I believe, however, that the formation of a thick protective mat should be discouraged, as this mat will very frequently lead to excessive maintenance costs in itself. The correct thickness of a surface mat should be determined by the texture of the surface and should be only such as will just cover the projecting tops of the surface stone. In what follows, a brief attempt will be made to outline present practice in Ohio, where I think the surface treatment has been developed in a very satisfactory manner.

General

A surface treatment consists in the application of about one-fifth to two-thirds of a gallon of tar or asphalt per square yard. This application is made either hot or cold, depending on the quality of the material and the season of the year; it also varies in kind and quality, depending on the requirements of the surface. Whether to use tar or to use asphalt in surface treatments has been a mooted question. This perhaps applies also to a choice between these materials in other maintenance work. An inexperienced or personally interested party can certainly mess up the work by arbitrarily deciding that such and such materials shall be used without regard to requirements or possible effects. It is a criminal shame that political expediency, inexperience, or personal interest should have the least say in this and allied maintenance and construction problems.

When it comes to a choice between tar and asphalt for surface treatments, the initial cost is but one of the items of consideration, and it is usually of minor importance. In general tar has the advantage of being suited to wider usage; whereas asphalt has longer life. Tar generally costs more than asphalt, but requires less covering and less subsequent watching; the initial cost of the treatment is by no means to be determined by the cost of the bituminous materials. Asphalt should not generally be applied so heavily as tar. In this respect its cost is reduced relatively, in spite of its large covering requirement. Tar can generally be placed on any surface; whereas asphalt usually requires a rough, previously treated surface. We have developed light, medium, and heavy bodied materials to take care of the various surface conditions. Cold asphalt and cold tar are the light materials, medium tar the medium, and hot tar and hot asphalt the heavy bodied materials. Heretofore, we have used practically nothing but cold tar as the light material. As noted before, however, we are developing a cold asphalt as a naphtha cut back from hot asphalt and expect to try it our during 1923. At the same time we have been using a light material of hot asphalt generally, rather than tar, as the heavy bodied material. In general a new waterbound road should have a penetrating treatment of light bituminous materials; a waterbound retreatment or bituminous macadam original treatment should generally require medium; a rough, well-voided, large-stoned previously treated surface might generally take a light treatment of heavy bodied material. Hot asphalt requires such an excess of screening and so careful watching that even the location of the proposed treatment should be given consideration. If traffic is heavy and the shipping point for covering remote and haul conditions bad, it should not be used, even if the surface conditions might warrant its use.

New Waterbound

We will now discuss in some detail the quantities and kinds of bituminous materials to use on the different macadam types. A new waterbound road should be given very careful cleaning before its first treatment. Its subsequent surface

maintenance depends very largely on its initial treatment. This type should be traveled considerably, if possible, before treatment, even if the surface starts to ravel. The treatment should not be applied after the fall rains start in, or at any time when the surface is not entirely dry to a depth of 3 or 4 ins. It should be very thoroughly swept with a rotary broom in good condition, entirely removing all surface dust and exposing the stone down as far as possible, even if some raveling occurs. If the edges or any other portion of the surface require the use of a light grader, or handwork, to remove a mat of dust or screenings, let same be used. The surface should be completely cleaned before treatment. As stated before our present material is cold tar and it is extremely satisfactory. It is sometimes combined with medium tar, where the length of the section is sufficient to warrant the shipping of each in tank car quantities. If nothing but cold tar is used, the first treatment consists of about one-third of a gallon per square yard. If the weather is quite warm, this material will be absorbed without covering, in one or two days. This will penetrate one-half inch or more and gives a surface the appearance of a penetration road. This application we then follow up with about ¼ gal. cold tar or 1/5 gal. medium tar, depending only on tank car grouping. These two materials are very similar, the higher limit of viscosity for cold tar approaching closely the lower limit for medium tar. As a covering for this treatment ¾ to ¼ in. crushed stone or slag, or ½ to 1/10 in. gravel is used; the quantity per mile of 16 ft. pavement varies because of the weight of the various materials, but runs approximately for this, 60 gal. treatment 100 tons for stone, 80 for slag, and 110 for gravel. If the cold tar can be absorbed without covering, as is often possible, deduct 20 tons from each of these figures. For this treatment it is not at all serious to have too small an amount of covering on hand, provided the supply is spread uniformly. At the same time it is preferable that an excess amount be on hand. It is also generally desirable that one side of a road be treated at a time, for the sake of traffic; but this treatment dries out so quickly that little inconvenience is experienced. It may be desirable to treat hilly country with cold tar or possibly cold asphalt always, so as to preserve roughness, without covering, or with but a very limited amount of covering.

Retreatments

A waterbound macadam retreatment should follow an original treatment the succeeding season; successive retreatments can usually follow every second or third season. There is generally very little difference between a waterbound retreatment and an original or retreatment on a bituminous macadam surface as to kind and quantity. It is usually satisfactory to apply about 0.30 gal. medium tar and, where conditions warrant, about 0.25 gal. hot asphalt. We have tried as low as 0.20 gal. medium tar, but the mat secured was found so thin as to do very little good and consequently required treatment the following year. It is my opinion that although the inconvenience does not last a great length of time, we owe it to traffic to avoid annual retreatments if it is possible to do so.

If the retreatment is tar, covering as specified for the original treatment may be used in quantity about two-thirds. If it is desired to produce a rough surface, due to hills, or special traffic requirements, such as a preponderance of horse-drawn vehicles, or heavy automobile traffic, a coarser covering should be specified, and of a hard crushed material. The use of a heavy roller is here necessary, in order to force the covering into the surface and crush the coarser element. In producing a rough surface it is necessary to avoid the use of asphalt, as this material naturally requires a great excess of covering and absorbs it, with the result that a uniform mat is produced that soon presents a fairly smooth surface. When hot asphalt is applied, the use of a roller should be dispensed with. The 0.25 gal. treatment absorbs as much covering as the 0.60 gal tar specified above, and it must be so completely covered in order to prevent its picking up that traffic is very little inconvenienced. Besides the use of the roller is very likely to cause picking up, due to its own weight and the freshness of the asphalt. It is true that traffic will kick off some of the covering, but this only goes to the edge of the road, and since this particular treatment needs close watching, there is thus provided along the edges an amount of covering that can readily be swept back into the surface in case of bleeding.

With this treatment it is imperative that surplus stock piles be distributed along the road at convenient places. For once picking up starts, it is almost impossible to prevent disaster unless the supply is at hand. Unlike tar, a hot asphalt picked up spot will not heal itself but

must be patched. If this treatment does start to pick up and no stock piles are on hand, a light application of dust from the shoulder upon the bleeding up spot may suffice to prevent further trouble. But in the preparation of a section for a hot asphalt treatment, the first care should be to stock along the road the surplus, and then distribute the covering. Do not repeat hot asphalt. Follow with a cold or medium treatment once or twice. Then use hot asphalt again, if desirable. This should tend to discourage waving. Hot asphalt should not follow itself after less than a four-year interval.

In Ohio we operate ten complete surface treating units. These consist of pressure distributor, camp truck, supply truck, rotary sweeper. Six men complete the personnel, not including, of course, the labor required for spreading covering material. Each of these outfits treated an average of 90 miles during 1922, showing that for the state as a whole, biennial treatments are required. The distributors range in capacity from 1,000 gals. to 600 gals., the lighter proving satisfactory in hilly country with scattered work. The camp truck is a 1922 innovation and has proved itself highly efficient. It houses all the men and is equipped for cooking purposes. These outfits were built up by crews themselves during the winter previous. Later on it is proposed to add to each unit a power covering spreader. Up to date there is nothing on the market that has proved satisfactory, in our estimation. Several horse-drawn spreaders are on the market, but it is our notion that the covering should be spread ahead of any part of the spreading unit, in order to secure good results. Spreading by hand is expensive and one can well afford to consider means of getting away from it, if possible. It is quite difficult to get covering spread uniformly by hand. However, when cast by shovel carefully good results can be secured, provided the laborer casts sideways and does not throw the covering in a pile and then attempt to spread it out with his shovel. I believe that well-designed mechanical spreader will reduce the cost of covering 1 ct. per sq. yd; or on a basis of cost of $8,000, and considering past volume of work, such a piece of equipment would pay for itself in one season. Our costs of treatments during 1922 were approximately as follows: Original 0.60 gal. waterbound, 12¼c per sq. yd.; 0.30 medium treatment, 7½c; 0.25 heavy treatment, 7¼c. The length of life is: Original one year; medium, two to three years; heavy, three years.

Resurfacing

It is my intention to discuss this subject in but a limited way. It is a very necessary part of the subject in hand from the standpoint of limiting expenditures on any existing surface. Varying with the volume of traffic, there is a certain limit beyond which we are not justified in carrying on our ordinary maintenance. This figure we have generally arbitrarily set as about $1,000 per mile (exclusive of the surface treatments) on light traveled and $2,000 to $3,000 per mile on heavily traveled sections. The construction item interest on investment has a certain bearing on the matter; but the requirements of traffic generally provide the deciding factor. It is sometimes advisable to resurface certain sections that might otherwise be held over a year, in connection with adjacent work, thus forcing traffic to detour but once for both jobs. In a little more than half of our macadam resurfacing mileage, a macadam type is used; in the remainder a more expensive is used, depending on costs, local conditions, and adjacent types. We will discuss madacam maintenance by widening, the use of penetration tar or asphalt, the extensive use of the cold or hot mix patch.

(*a*) *Widening*

It is the general failing of a macadam road to increase in crown under traffic, due to both lateral and vertical yielding. Where this has progressed to a point where ordinary edge patching is not economical and a complete resurfacing is not necessary, it can be very well taken care of by feather-edged widening, because it is generally true that failure of this kind is due to insufficient width. In doing work of this kind it is customary with us to consider the results secured as base course work, even though resurfacing be not contemplated as a part of the operation, and secure a width 2 ft. in excess of the ultimate resurfacing width, thus providing a sub-shoulder that will tend to reduce lateral yielding under traffic. The edge of the old pavement is not disturbed by the widening, which is generally excavated to a depth several inches below the base of the old metal and filled and rolled waterbound flush with the top of the existing surface. Then an additional course is added sufficiently thick at the edge to feather over toward the center so as to produce a uniform crown of 3 ins. in 9 ft. But one size of stone is used, even though the feather edge be quite thin. It is necessary that the quality of the stone be good, in order to reduce the crushing to a minimum. The same operation is re-

peated on the opposite side. The difficult job consists in preventing raveling toward the center. This is accomplished by the use of the bituminous patch. Inasmuch as this kind of work can usually be done under traffic, it is quite necessary to follow up closely with this patching. Usually the cut back patch can be feathered out where the depth is not too great; on the deep spots the use of the penetration patch is to be preferred; all this patching to be perfected by the use of the roller. Careful patching will result in a very uniform crown. Immediately on completion and drying out this feather-edge widening should receive a careful brooming and a light bodied treatment sufficient in quantity (say 0.40 gal per sq. yd.) followed up by a treatment of the entire surface, so as to seal up the patching and produce a uniform-appearing surface, so that traffic will not feel inclined to be skeptical as to what portion of the surface should be used. We had a sample of the above work on a section of the National Road during 1922. This was widened to 20 ft. and feather-edged, with the expectation of resurfacing 18 ft. bituminous penetration. The results secured were so very satisfactory that the top was omitted and the surface has every appearance of an entirely new job, and is undoubtedly good for several years, permitting the use of the additional money in other work.

(*b*) *Use of Tar or Asphalt*

The preferential use of tar or asphalt in penetration work might receive brief attention. Generally, in minor patching, with the use of a heating kettle, tar is to be preferred, due to its lower melting point. On extensive patching or resurfacing, several elements deserve consideration, such as size and quality of stone, season of year, relative costs. It frequently happens in a late seasonal application that the bituminous materials are insufficently heated, due to natural causes.

Asphalt is more likely to be underheated in this case and therefore not give the desired penetration. Moreover, since it has a high melting point, it never gets very fluid and is not likely to flow into the lower voids. During mid-season, on the other hand, this property acts to the advantage of asphalt, because an asphalt penetration road bleeds very little or none at all during the summer. The size of stone has considerable to do with the desirability of using either one or the other material.

I should like to digress for a moment. It is my opinion that there has been too general a usage of small stone in penetration work. After earnest solicitation, the Ohio Department of Highways specifications for 1923 were altered, requiring number one aggregate for this purpose, previously having specified number two. The size is now 3½ to 2½ ins., number two being 2½ to 1½. The only argument I can see in the use of smaller stone is that of getting a smoother top with the finer stone. On the other hand, the rougher surface secured with the coarser stone gives a much better bond with the surface treatments later applied, and assists us in keeping away from one big disadvantage of this type, namely, extreme slipperiness in cold weather. When the stone is fine and the voids small, tar is likely to penetrate farther than asphalt. When the stone is coarse, asphalt is to be preferred. If it is determined to construct a penetration road and soft stone must be used, it should be absolutely free from small sized material. Whereas, hard stone should be thoroughly keyed before the bituminous material is applied, soft stone should receive by far the major portion of its rolling after the application, and a greater quantity of bituminous material should be applied. When hard stone is used it is possible to get along with as little as 0.8 gal. of tar or 0.75 gal asphalt per sq. yd. per inch depth of finished road. In case the filler sinks below the top, as is quite probable in this case if tar is used, excessive rolling must be done to bring it back to the surface. Many a hard stone penetration top has raveled badly, due to lack of rolling. Any contractor who realized the difference would seldom take a cheaper soft stone, if he could get a more expensive hard stone that would stand considerable rolling, especially if he is being paid unit prices on bituminous materials. If soft stone is used asphalt is to be preferred, as it will stand nearer the surface after application.

(*c*) *Extensive Use of Rock Asphalt*

And now for a few final words regarding the extensive use of the cold or hot mix patch. There is a little theoretical difference between a small job and a large. However, on large work of this kind, amounting to resurfacing, the commercial introduction of Rock Asphalt has shown it to be a material of very high merit. Sections in service in some places receive a very considerable volume of traffic, much of which is heavy, and at an extremely low surface maintenance cost. Others, due to improper construction, have high maintenance costs. We have resurfaced

in large patches existing hot mix surfaces that had become extremely wavy. The material is very well adapted, requiring but rakes and a roller. In a short time it is difficult to tell this material from the rest of the road. When an error is made in the use of this material, it usually occurs in connection with macadam base construction, either in making the base too thin or too narrow. The base should be made ample in thickness, just as though it were to be the finished road. It should be made at least a foot and a half wider on each side, both to resist lateral yielding and to avoid the necessity of laying this asphalt on the screening mat that usually lays on the outer edge of a waterbound macadam road. A large hard stone should be the macadam aggregate, well keyed, well built, and well voided on the surface. The asphalt if carefully raked and carefully edge-tamped and not over-rolled will prove very satisfactory. Rolling should be done during the heat of the day, once over, and repeated the first and second day following. Any amount can be built before rolling, provided traffic be kept off.

The foregoing matter is from a paper presented at the recent Road School at Purdue University.

CONDENSED MANUAL OF SEWAGE WORKS OPERATION

(Editor's Note—Some months ago the Burns & McDonnell Engineering Co. of Kansas City, Mo., issued a pamphlet entitled, "A Guide to the Operation of Sewage Treatment Plants." Reproduction of this valuable matter in this magazine has been postponed until it could be reproduced in full.)

The design of a sewage treatment plant vitally affects its efficiency, but no plant has ever been designed which will continue to operate satisfactorily without attention. Unfortunately neglect of these plants seems to be the rule rather than the exception. The amount of labor required is, of course, dependent somewhat upon the size of the plant, but regular attention is essential for the efficient working of any plant. It may be that a short time each day will suffice, but the small amount of attention required does not justify omitting it altogether.

The care of a plant is not difficult and any intelligent man who will follow instructions can operate a plant successfully. A recognition by the city officials that the plant requires attention and an operator willing to follow directions conscientiously and give the necessary attention are the essentials.

A sewage treatment plant neglected and giving bad results always gives grounds for criticising the city administration and frequently the city officials blame the designing engineer, when the fault is really lack of care and attention. A poorly designed and cheaply built plant with good care and attention in operation will often give far better results than the finest kind of plant which may be neglected in operation.

In a recent decision of the Texas Court of Civil Appeals damages, due to negligent operation of a sewage disposal plant, were awarded a private individual from the City of Honey Grove, the court holding that the liability of the city does not differ from that of an individual who so wrongfully and negligently manages his property as to injure another person. The jury made the finding of fact that the alleged nuisance was abatable by the exercise of ordinary care in the operation of the plant.

The following guide to the operation of sewage treatment plants is based upon 25 years' experience in the design of sanitary projects, numbering over 120 plants and involving an expenditure of $7,500,000.00. It does not purport to be a complete set of instructions, but represents an attempt on our part as consulting engineers to stimulate the interest of the city officials in their treatment plants and an endeavor to co-operate for the efficient operation of these plants.

No guide to the operation of treatment plants can cover all cases and at times unforseen problems may arise due to a period of neglect or to local conditions which cannot be solved by the regular operator. At such times expert advice will be required and cities should confer with consulting engineers or the sanitary engineer of the State Board of Health. The employment of engineers to advise concerning operation of plants and closer co-operation with State Boards of Health would go far toward transforming many well-designed plants from a state of neglect to one of efficient operation.

Nature of Sewage

Great variation in quantity and quality of sewage exists in different cities, due to entrance of seepage water, roof water, and industrial wastes into the sewers. For economical and efficient operation of a treatment plant it is desirable that a minimum of seepage and no roof water

be allowed to enter. Fresh sewage is desired for Imhoff tank treatment. Some industrial wastes, such as tar and oil from gas plants and refineries and washings from garages are particularly troublesome; stringent regulations should be enforced by cities to prevent such wastes from reaching the sewers to keep their treatment plants operating efficiently.

No raw sewage should be by-passed except when absolutely necessary.

Grit Chambers

Screens should be cleaned at least once per day and more often if necessary.

Grit chambers should be cleaned out whenever the accumulation of grit becomes such that grit tends to wash through; removed contents should be buried, or dried on sludge bed.

Septic Tanks

Inlet and outlet channels and weirs should be kept clean.

Sewage solids will accumulate as settled sludge or floating scum; contents of tank should be disturbed as little as possible. When combined depth of scum and sludge equals one-quarter of the tank depth, the solids should be removed, preferably in spring or fall, when sludge will dry quickly.

Removed material may be buried, or dried on sand beds. No open flame lamps should be taken into any septic tank on account of the explosive character of accumulated gases.

Imhoff Tanks

Channels.—All channels should be cleaned at frequent intervals and always before reversal of flow, using care that deposits are not washed into tanks.

Settling Chambers.—When putting Imhoff tanks into service for the first time, or after pumping out and cleaning, if sewage is concentrated and flow heavy, the tanks should be filled with the more dilute night flow or clear water and the amount of sewage admitted to the tanks gradually increased, in order to build up the bacterial action.

Non-settleable material, such as oil and grease should be skimmed off daily, burying or burning it.

Settleable material behind baffles and scum on surface of settling chambers should be skimmed off daily, throwing it into gas vents.

All vertical walls and sloping bottoms of settling chambers should be cleaned with rubber squeegees slowly, forcing the deposit entirely through the slot, taking care that the deposit is not stirred up and carried into outlet.

When reversing channels are provided the flow through the tanks should be reversed every week or two, previously skimming off all floating materials behind inlet baffles and squeegeeing all wall surfaces between baffle and end wall at inlet and allowing time for settlement.

Gas Vents.—The scum in the gas vents should be broken up daily by sprinkling with water or agitating with a rake to release the entrained gases and any material which cannot be made to settle should be removed and buried or burned.

If foaming occurs and cannot be controlled, the city should advise with its consulting engineer or the sanitary engineer of the State Board of Health.

Sludge Chamber.—Sludge should not be allowed to accumulate nearer than 18 ins. to the slot at the bottom of the settling chamber. The surface of the sludge may be determined by means of a wood or sheet iron plate attached to a wire or light rod.

Sludge should be removed at intervals by opening valves slowly on sludge pipes, it being better to remove small amounts frequently than large amounts infrequently.

Sludge should be drawn off slowly to allow continuous settlement of sludge around base of sludge pipe; only well-digested sludge should be withdrawn, known by its brownish-black color, more or less granular and frothy appearance, and faint tarry or rubbery odor as opposed to the grayish color, sticky and pasty appearance and foul odor of partly digested sludge.

Late each fall the entire amount of digested sludge should be withdrawn to provide sufficient storage capacity for winter sludge.

Vertical and horizontal sludge pipes should be cleaned by rodding to break up old deposits before opening valves. The sludge pipe may be backfilled with water or settled sewage after drawing sludge.

At intervals of several years, dependent upon local conditions and kind of plant operation, the tanks may require to be pumped out and cleaned out thoroughly.

Sludge Beds

Sludge should not be drawn upon the bed until all dried sludge has been removed therefrom; well-digested sludge only should be dried upon the bed and should be drawn to a depth preferably not over 6 to 8 ins. and never over 12 ins.

When thoroughly dried the sludge

should be removed, being careful to remove as little filter sand as possible, and may be used for filling in low places without nuisance, or for lightening and furnishing humus to heavy soils.

Thin layers of sand should be applied to the bed from time to time to compensate for losses during removal of sludge.

Dosing Chamber

Before starting the siphon should be filled with water and all pipe connections to the siphon should be kept continuously air-tight.

The sides and bottom of the dosing chamber should be cleaned down occasionally, and all floating material should be skimmed off frequently.

Sprinkling Filters

Sprinkling nozzles should be examined daily and kept clean.

The surface of the stone should be kept free from leaves, papers, and vegetable growth.

In case organic growths in the bed and moth-flies with their larvae become troublesome, chemicals such as caustic soda, copper sulphate or hypochlorite of lime may be used in proper quantities for their control.

When the condition of the surface becomes such that free percolation is not secured, the surface stone should be removed, washed, screened and replaced; at longer intervals, dependent upon kind of operation and quality of stone, the entire bed may require washing and screening.

Final Settling Tank

The sludge should be removed frequently so that it will not become septic.

Contact Filters

The apparatus for filling and emptying the beds should be examined frequently and kept in perfect operation.

The surface of the stone should be kept free from foreign material and vegetable growth.

When the stone becomes clogged with sewage solids, at intervals of five years, more or less, the entire bed of stone will require to be removed, washed, screened and replaced.

Sand Filters

Sand beds should be dosed alternately to allow cleaning, resting and drying. The distributors should be regulated to secure even distribution of sewage.

Before dosing any accumulated sludge should be removed and the bed raked lightly to a depth of ½ in. to break the surface.

When the bed becomes clogged so that sewage will not percolate, the surface sand should be scraped off to a depth of 1 in. and raked. At longer intervals new sand of situable quality must be added to the bed.

Teams and heavy loads should not be driven over the bed. Holes should not be dug into the sand to pass sewage directly to drains and any wash-ins should be repaired at once. No growth of vegetation should be allowed on the bed.

In the northern states the sand should be piled or ridged in late fall for winter operation to prevent ice from freezing to the sand, and every opportunity utilized for cleaning the bed.

GREENSBURG, IND., GAS AND ELECTRIC CO. STORES FUEL OIL IN CONCRETE TANK

By R. F. Lee, 302 West First St., Greensburg, Indiana.

The Greensburg Gas and Electric Company of Greensburg, Indiana, has provided a very convenient and substantial method of storing its fuel oil for a 250 h.p. Deisel type engine direct connected to generator.

The company at first intended to construct a steel tank above ground, but was soon convinced that the hazard from lightning, fluctuating temperature of oil with the surrounding temperature, maintenance expense and extra pumping facilities warranted the investigation of underground tanks. On the other hand, the company found tanks constructed of concrete which were serving their purpose very satisfactorily.

Plans prepared by the Truscon Steel Company were adopted. These plans conformed to the recommendations and specifications for storage reservoirs of the American Concrete Institute.

The tank as designed and built is 70 ft. long by 30 ft. wide by 9 ft. 11 ins. high, outside dimensions. The floor is 8 ins. thick, reinforced with expanded metal; the walls are 12 ins. thick reinforced with Kahn and rib bars; and the roof is joist construction, the joists being 5 ins. wide and 10 ins. deep with a 3 in. slab on top. There is a partition wall through the center of the tank which serves as a support to the roof as well as dividing the tank into two compartments.

Excavation was made with slips after the material had been loosened by plowing or picks. Solid rock was reached at a

depth of 6 ft. The floor was then placed with the edges formed to key to the walls. A galvanized strip 8 ins. wide sealed the joint. Dowel holes were drilled in the solid rock along the center of the walls and dowels inserted to engage the walls and thus avoid any movement of them. Forms were started on the floor and raised to position and braced. The walls were constructed in one continuous operation. The forms and reinforcing for the roof were placed and the roof and manholes built.

After the roof had hardened for two weeks and before the supporting timbers had been removed a top covering of 18 ins. of earth was placed with teams and slips.

Following the removal of the inside forms an oil proofing of calcium silicate was applied to the inside walls and floor in four coats, 24 hours apart, by the use of a hand pump and 50 ft. of garden hose and nozzle.

The cement was obtained from local dealer; sand and gravel shipped from Columbus, Indiana, unloaded by hand, hauled in wagons and fed to mixer by wheel barrows; and water was from the city supply. Concrete was mixed by an 11 cu. ft. capacity, steam driven Smith mixer and placed in forms by two-wheeled concrete carts.

During the last 2 ft. of excavation, placing of floor, building of wall forms and until the walls were partially built seepage water was removed by a 3 in. centrifugal pump, driven from the flywheel of the engine on the mixer.

The tank as built holds 125,000 gals. of oil. The oil is conveyed to the tank by a 3 in. pipe line from a siding 2½ blocks distant at an elevation of about 17 ft. above the top of the tank. The author was the contractor on this job.

STUDIES OF BUILDING HEIGHTS LIMITATIONS IN LARGE CITIES

Editor's Note: The Chicago Real Estate Board recently issued a book entitled: "Studies of Building Heights Limitations in Large Cities," which is one of the most valuable books on certain phases of Zoning yet published. The following review of the book was written by Wm. Artingstall, Civil Engineer, 1206 Tribune Bldg., Chicago, who was the only engineer on the Chicago Zoning Commission appointed about two years ago.)

To the Engineer, Architect and the City Planner, questions treating of the various phases of Zoning are sure to attract attention. Unfortunately, however, few publications expose the fundamentals that enter into this important subject. Not so with the latest contribution to the subject just issued by the Chicago Real Estate Board through its Committee on Zoning under the direction of its chairman, Charles M. Nichols.

The Chicago Real Estate Board, during the past year desired to secure first hand information for its members and instituted a series of meetings as a means of disseminating the results of serious and intensive studies on the effect of high buildings and their relation to the subject of Zoning. Although these meetings were intended primarily for the education of its members, public interest became so aroused that it was necessary to utilize their large assembly hall in order to accommodate the "outsiders" desiring to attend. The mimeographed proceedings were soon exhausted but the Board authorized publication of the transactions and enriched them with contributions from nationally recognized authorities.

Appreciating our own limitations, no attempt is here made to review the various topics treated in the present volume of about three hundred pages; but, there are usually two sides to every question and the seemingly desirable or undesirable features are ably presented by their sponsors. We cannot, however, resist the temptation to mention the classical contribution of Mr. George C. Nimmons, the well known architect, in which he predicts the "Passing of the Skyscraper." "The diminishing rate of return," states Mr. Nimmons, "will in the near future prohibit the erection of extraordinarily high buildings for investment purposes," and he presents ample data to support his statement. Corroborative supporting data is contributed in a paper by Mr. Carl Schultz, president of the National Association of Building Owners and Managers. The latter has access to considerable data not available to the ordinary person and while his contribution is valuable, it is doubtful if the engineer will agree with some of Mr. Schultz's elastic conclusions or sanction a disregard of established economic facts. Building construction did not cease in 1907-8 and in 1917 because a legal limitation was imposed on height. These dates are too recent to forget the issuance of 'Certificates of indebtedness' during the 'black panic' of 1907 or the 'priority orders' which certainly were not granted for the construction of office

buildings during the late war. While some of us have very vivid recollections that there was a stringency in the money market for several years after the World's Fair boom (Chicago, 1893) that probably had far more effect on the building construction than did any city ordinances.

There is an extremely valuable exposition of the principles and practice of Zoning by Mr. Edward M. Bassett, chairman of the New York Board of Appeals, and a preface by the same authority. Another particularly instructive paper is that showing the Relation of High Buildings to Fire Hazard and Panic, by Sidney Williams, of the National Board of Fire Underwriters.

Public Health, Public Safety, Traffic and Transit, and Economic Considerations form other chapters, while Regulations in European and American Cities, and digests of various zoning ordinances add to the value of the publication.

The book has been reviewed by many of the daily papers and monthly publications and favorably commented upon at length by the Economist which states that "this is the most complete investigation on the subject ever yet undertaken."

"Studies on Building Heights Limitation in Large Cities," 300 pages. Cloth, $2.60 postpaid. Chicago Real Estate Board.

HARDNESS OF LARGE PUBLIC WATER SUPPLIES IN THE UNITED STATES

The difficulty of using hard water in the home is rather generally known. Much more serious troubles, however, are encountered in the industrial use of hard water and large amounts of money are spent each year in softening hard water for industrial use and in repairing damages resulting from the use of unsoftened hard water.

If the hardness of a water, expressed in the ordinary way as equivalent calcium carbonate, is less than 50 parts per million comparatively few persons notice the hardness in ordinary use. Such water may be called soft.

If the hardness is between 50 and 100 parts per million most persons would notice it but not be greatly troubled by it. Practically all industrial plants, where hardness is detrimental, would find it profitable to soften the water. It might bet called slightly hard.

Water with hardness between 100 and 200 parts per million hard without any qualification. Treatment is profitable for household use and for nearly every industrial use where hardness affects the value of a water. Water with hardness over 200 parts per million may be called very hard. Very few waters used for public supplies have hardness over 400 parts per million.

Analysis of water from the public supplies of over 300 large cities in the United States show that the average hardness of the surface water supplies in parts per million is 85 and of the ground water supplies is 226. Surface supplies are used by 34,000,000 of the 39,000,000 inhabitants of these cities. The general average hardness for all supplies is, therefore, 99 parts per million.

The hardness of some of the larger supplies is much below the average. The Boston supply, the Catskill supply of New York City, and several smaller supplies have hardness of less than 25 parts per million. The Croton supply of New York City and the Delaware River supply of Philadelphia have a hardness of about 50 parts per million.

The hardness of the water from Lake Michigan used in Chicago is about 130 parts per million. Other cities on Lake Michigan and the other Great Lakes use water with about the same hardness.

The average hardness of the large water supplies of states along the Atlantic coast and the east Gulf of Mexico is less than 55 parts per million except for Florida. The average hardness of the four large supplies of Florida is 296 although the hardness of the Pensacola supply is only 3. Public supplies in the Central States are nearly all hard or very hard. A number of them are softened in connection with their filtration for sanitary purification.

The foregoing matter is an abstract of a paper by W. D. Collins, Chief of the Quality of Water Division of the U. S. Geological Survey, presented recently before the Philadelphia Section of the American Chemical Society. The full paper was a discussion of material prepared for publication, within the next few months, as a water supply paper with the title: "The Industrial Utility of Public Water Supplies in the United States.

Construction News and Equipment

LIGHT MOTOR TRUCK HAULAGE AS APPLIED TO THE CONSTRUCTION OF CONCRETE HIGHWAYS

By A. E. Horst, Secretary-Treasurer of Henry W. Horst Co., Rock Island, Ill.

Probably the most serious of all consideration in connection with successful planning of the completion of highway contracts should be given to the problem of transporting materials which go into the construction of the highway,—from the base of delivery to the road proper.

·INVESTMENT-SINGLE UNITS·			
	TYPE 1	TYPE 2	TYPE 3
NUMBER BATCHES HAULED	1	2	4
WEIGHT-LOAD IN TONS HAULED	1.6	3.2	6.4
COST TRUCK COMPLETE-READY TO OPERATE	$ 1,000.00	$ 4,000.00	$ 5,000.00
LICENSE ONE YEAR	12.00	15.00	60.00
LIABILITY PROPERTY INSURANCE	42.00	42.00	48.00
FIRE·THEFT INS - ONE YEAR	20.00	50.00	60.00
STORAGE 12 MONTHS	46.00	60.00	60.00
NET TOTAL	1,122.00	4,167.00	5,228.00
INTEREST @ 7%	78.00	293.00	366.00
TOTAL INVESTMENT	1,200.00	4,460.00	5,594.00
AVER EXP. PER YEAR	700.00	+ 1,793.00	1,844.00
OPERATING COSTS -	GAS 25¢ PER GAL - OIL 60¢ PER GAL		
	TYPE 1	TYPE 2	TYPE 3
GAS. PER MILE TRUCK OPERATION	2.5¢	5.0¢	6.2¢
OIL · · · ·	.5¢	.5¢	1.0¢
TIRES · · · ·	1.5¢	5.0¢	6.0¢
REPAIRS · · ·	2.0¢	3.5¢	4.0¢
TOTAL · · · · ·	6.5¢	14.0¢	17.2¢

CHART NO. 1—BASIC FIGURES FROM WHICH CHART NOS. 2 TO 5 WERE BUILT UP. THE ACTUAL FIGURES USED IN THESE GRAPHS ARE SHOWN IN TABLE I.

The three methods of such transportation in common practice today are:

1. Industrial Railway.
2. Heavy Trucks.
3. Light Trucks.

I find it a fact that many contractors do not know definitely what their hauling costs are. They may know that it cost a total of so many thousand dollars to haul the material on a certain job which they have completed, but to pull this total cost down and analyze it properly is a matter of mere guess in most cases.

After having especially discussed this subject with a number of contractors who should be in a position to know exactly what their costs are, I find it little wonder that a real salesman of trucks can make his costs look so low that he is able to sell, for a particular job, a fleet of trucks the operation of which will show actual costs far in excess of estimated costs. Until we analyze these costs we are in no position to check up definitely on whether or not trucks are likely to deliver according to the predetermined estimate.

Of course a truck manufacturer may show by figures or otherwise that his particular truck is most adaptable for hauling material on highway contracts. However, it is for the contractor himself, who is obliged to purchase trucks, use them, maintain and operate them and keep them in storage or occupied during the season that they are not in use on highway work, to decide which is the best investment and which trucks ought to be purchased.

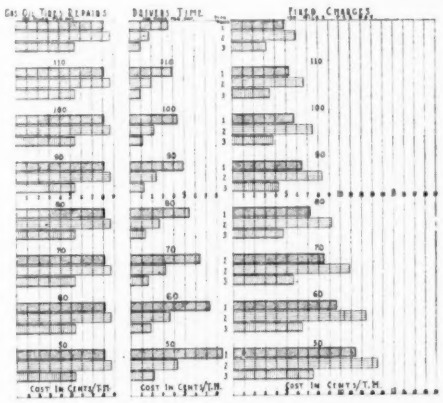


CHART NO. 2—GRAPHS SHOW, ON THE LEFT SIDE, GAS, OIL, TIRE AND REPAIR COST. IN CENTER, DRIVER'S TIME. ON RIGHT, FIXED CHARGES. ALL ON BASIS OF TON MILE AND UNDER DESIGNATED MILES PER DAY COMPARING THREE TYPES OF TRUCK; TYPE 1, SMALL; TYPE 2, MEDIUM; TYPE 3, LARGE. FIXED CHARGES ARE DEPRECIATION PLUS LICENSE, INSURANCE, STORAGE AND INTEREST EXPENSE.

Of assistance in determining the eco-

TABLE I—ELABORATED STATISTICS OF CHART NO. 1 ON BASIS OF DAILY RUN OF 50—60—70—80—90—100—110—120 MILES.

	Miles a day			50			60			70			80		
1.	Working days per year			150			150			150			150		
2.	Miles per year			7,500			9,000			10,500			12,000		
3.	Average mile haul			1.5			1.5			1.5			1.5		
4.	Trips per day			17			20			23			27		
		No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3		
5.	Tons hauled each trip	1.6	3.2	6.4	1.6	3.2	6.4	1.6	3.2	6.4	1.6	3.2	6.4		
6.	Ton miles per day	41	82	164	48	96	192	55	110	220	65	129	260		
7.	Investment per unit	1,000	4,000	5,000	1,000	4,000	5,000	1,000	4,000	5,000	1,000	4,000	5,000		
8.	Charge off per year	700	1,793	1,844	700	1,793	1,844	700	1,793	1,844	700	1,793	1,844		
9.	T. M. hauled each year	6,160	12,300	24,600	7,200	14,400	28,800	8,250	16,500	3,300	9,750	19,400	39,000		
10.	Fixed cost per T. M.	11.4	13.5	7.4	9.7	12.4	6.4	8.5	10.9	5.6	7.2	9.2	4.7		
11.	Driver cost per 150 days	525	525	525	525	525	525	525	525	525	525	525	525		
12.	Driver cost per T. M.	8.5	4.3	2.1	7.3	3.6	1.8	6.4	3.2	1.6	5.4	2.7	1.3		
12a.	Driver plus fixed cost per T. M.	19.9	17.8	9.5	17.	16.	8.2	14.9	14.1	7.2	12.6	11.9	6.		
13.	Gas, oil, tires, repairs per mile	6.5	14.	17.2	6.5	14.	17.2	6.5	14.	17.2	6.5	14.	17.2		
14.	Gas, oil, tires, repairs T. M.	7.9	8.5	5.2	8.1	8.4	5.4	8.3	8.9	5.5	8.	8.7	5.3		
14a.	Driver, plus gas, etc., T. M.	6.4	12.8	7.3	15.4	12.	7.2	14.7	12.1	7.1	13.4	11.4	6.6		
15.	Total cost T. M.	27.8	26.3	14.7	25.1	24.4	13.6	23.3	23.	12.7	20.6	20.6	11.3		
16.	Theoretical trucks needed 435 T. M. per day	10.6	5.3	2.7	9.	4.5	2.3	7.9	3.9	1.9	6.7	3.4	1.7		
17.	Actual trucks needed	11	6	3	9	5	3	8	4	2	7	4	2		
18.	Investment in fleet	11,000	24,000	15,000	9,000	20,000	15,000	8,000	16,000	10,000	7,000	16,000	10,000		
	Six Miles Work														
19.	Fixed cost	3,900	4,700	2,600	3,300	4,300	2,200	2,900	3,800	1,900	2,500	3,200	1,600		
20.	Gas, oil, etc.	5,700	4,400	2,500	5,300	4,100	2,500	5,100	4,200	2,400	4,600	3,900	2,300		
21.	Total cost	9,600	9,100	5,100	8,800	8,400	4,700	8,000	8,000	4,300	7,100	7,100	3,900		
22.	Remaining investment	7,100	19,300	12,400	5,700	15,700	12,800	5,100	12,200	8,100	4,500	12,300	8,400		
	Twelve Miles Work														
23.	Fixed cost	7,800	9,400	5,200	6,600	8,600	4,400	5,900	7,600	3,800	5,000	6,400	3,200		
24.	Gas, oil, etc.	11,400	8,800	5,000	10,600	8,200	5,000	10,200	8,400	4,800	9,200	7,600	4,600		
25.	Total cost	19,200	18,200	10,200	17,200	16,800	9,400	16,000	16,000	8,600	14,200	16,200	7,800		
26.	Remaining investment	3,200	14,600	9,800	2,300	11,400	10,600	2,200	8,400	6,200	2,000	9,600	6,800		

TABLE I CONTINUED—ELABORATED STATISTICS OF CHART NO. 1 ON BASIS OF DAILY RUN OF 50—60—70—80—90—100—110—120 MILES.

	Miles a day			90			100			110			120		
1.	Working days per year			150			150			150			150		
2.	Miles per year			13,500			15,000			16,500			18,000		
3.	Average mile haul			1.5			1.5			1.5			1.5		
4.	Trips per day			30			33			37			40		
		No. 1	No. 2	No. 3	No. 1	No. 2	No.3	No. 1	No. 2	No. 3	No. 1	No. 2	No. 3		
5.	Tons hauled each trip	1.6	3.2	6.4	1.6	3.2	6.4	1.6	3.2	6.4	1.6	3.2	6.4		
6.	Ton miles per day	72	144	288	80	160	320	89	178	356	96	192	384		
7.	Investment per unit	1,000	4,000	5,000	1,000	4,000	5,000	1,000	4,000	5,000	1,000	4,000	5,000		
8.	Charge off per year	700	1,793	1,844	700	1,793	1,844	700	1,793	1,844	700	1,793	1,844		
9.	T. M. hauled each year	10,800	21,600	43,200	12,000	24,000	48,000	13,300	26,800	53,400	14,400	28,900	57,600		

10.	Fixed cost per T. M.	6.5	8.3	4.3	5.8	7.5	3.8	5.3	6.7	3.5	4.9	6.	3.2
11.	Driver cost per 150 days	525	525	525	525	625	525	525	525	525	525	525	525
12.	Driver cost per T. M.	4.9	2.4	1.2	4.4	2.2	1.1	3.9	2.	1.	3.6	1.8	.9
12a.	Driver plus fixed cost per T. M.	11.4	10.7	5.5	10.2	9.7	4.9	9.2	8.7	4.5	8.5	7.8	4.1
13.	Gas, oil, tires, repairs per mile	6.5	14.	17.2	6.5	14.	17.2	6.5	14.	17.2	6.5	14.	17.2
14.	Gas, oil, tires, repairs T. M.	8.1	8.7	6.4	8.1	8.7	5.4	8.1	8.6	5.4	8.1	8.8	6.4
14a.	Driver, plus gas, etc., T. M.	13.	11.1	6.6	12.5	10.9	6.5	12.	10.6	6.4	11.7	10.6	6.3
15.	Total cost T. M.	19.5	19.4	10.9	18.3	18.4	10.3	17.3	17.3	9.9	16.6	16.6	9.5
16.	Theoretical trucks needed 435 T. M. per day	6.	3.1	1.5	6.5	2.7	1.3	4.9	2.4	1.2	4.5	2.3	1.1
17.	Actual trucks needed	6	4	2	6	3	2	6	3	2	6	3	2
18.	Investment in fleet	6,000	16,000	10,000	6,000	12,000	10,000	5,000	12,000	10,000	5,000	12,000	10,000
	Six Miles Work												
19.	Fixed cost	2,200	2,900	1,500	2,000	2,600	1,300	1,800	2,300	1,200	1,700	2,100	1,100
20.	Gas, oil, etc.	4,500	3,800	2,300	4,300	3,800	2,300	4,100	3,700	2,200	4,000	3,700	2,200
21.	Total cost	6,700	6,700	3,800	6,300	6,400	3,600	5,900	6,000	3,400	5,700	5,600	5,300
22.	Remaining investment	3,800	13,100	8,500	4,000	9,400	8,700	3,200	9,700	8,800	3,300	9,900	8,900
	Twelve Miles Work												
23.	Fixed cost	4,400	5,800	3,000	4,000	5,200	2,600	3,600	4,600	2,400	3,400	4,200	2,200
24.	Gas, oil, etc.	9,000	7,600	4,600	8,600	7,600	4,600	8,200	7,400	4,400	8,000	7,400	4,400
25.	Total cost	13,400	13,400	7,600	12,600	12,800	7,200	11,800	12,000	6,800	11,400	11,600	6,600
26.	Remaining investment	1,200	10,200	7,000	2,000	7,800	7,400	1,400	7,400	7,600	1,600	8,800	7,800

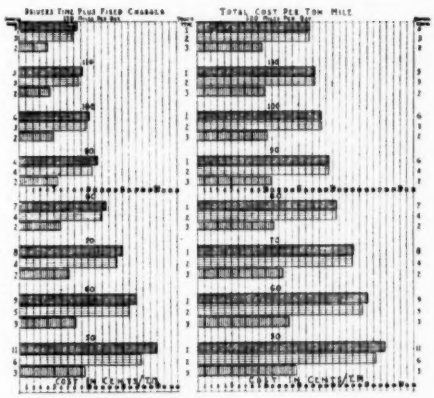


CHART NO. 3—LEFT SIDE SHOWS DRIVER'S TIME PLUS FIXED CHARGES. RIGHT SHOWS TOTAL COST, BOTH ON BASIS OF TON MILE AND ON THREE TYPES OF TRUCK OPERATING 50 TO 120 MILES PER DAY.

nomical equipment to purchase are the following conditions:

General Conditions

1. Distance materials are to be hauled.
2. Will the road support the wear and tear of heavy traffic?
3. Time lapse before getting onto subgrade after rain.
4. Investment allowed in estimate for hauling equipment.

Investment

1. Comparative original costs.

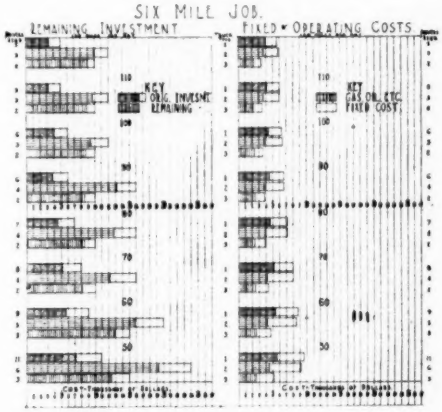


CHART NO. 4—GRAPHS ON LEFT SHOW REMAINING INVESTMENT AND ON RIGHT SHOW FIXED AND OPERATING COSTS, THE THREE TYPES OF TRUCK OPERATING FROM 50 TO 120 MILES PER DAY USING A 6 MILE JOB WITH AVERAGE HAUL OF 1.5 MILES AS BASIS OF COMPARISON.

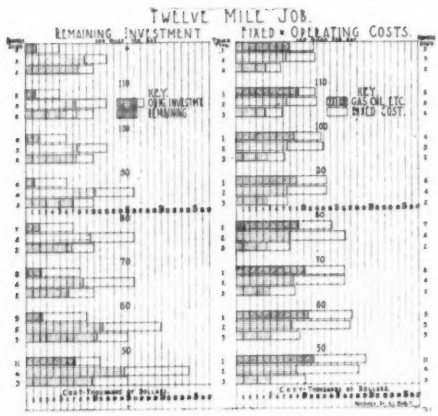


CHART NO. 5—LEFT GRAPHS SHOW REMAINING INVESTMENT AND RIGHT GRAPHS SHOW FIXED AND OPERATING COSTS, THE THREE TYPES OF TRUCK OPERATING FROM 50 TO 120 MILES PER DAY USING A 12 MILE JOB WITH AVERAGE HAUL OF 1.5 MILES AS BASIS OF COMPARISON.

2. Comparative depreciation.
3. Comparative investment in proportion to load-per-day carried.

Operation and Maintenance

1. (a) Ease of securing drivers.
   (b) Rate of pay.
2. (a) Ease of securing experienced mechanics.
   (b) Rate of pay.
3. (a) Ease of securing mechanical parts and comparative costs.
   (b) Will stocking of parts be necessary?
   (c) Likelihood of delay in waiting for parts.

COMPARISONS

	SIX MILE JOB — CASE I			TWELVE MILE JOB — CASE III		
	TYPE 1	TYPE 2	TYPE 3	TYPE 1	TYPE 2	TYPE #3
MILES PER DAY	120	100	80	120	100	80
NO TRUCKS	5	3	2	5	3	2
INVESTMENT FLEET	$ 5,000	$12,000	$10,000	$ 5,000	$12,000	$10,000
FIXED CHARGE	1,700	2,600	1,600	3,400	5,200	3,200
GAS OIL ETC	4,000	3,800	2300	8,000	7,600	4,600
TOTAL COST	5,700	6,400	3900	11,400	12,800	7,800
REMAINING INVESTMENT	3,300	9,400	8400	1,600	6,800	6,800
APPARENT DIFFERENCE BETWEEN TYPE 1 AND TYPE 3		$1,800			$3,600	

	SIX MILE JOB — CASE II			TWELVE MILE JOB — CASE IV		
MILES PER DAY	100	80	60	100	80	60
NO TRUCKS	6	4	3	6	4	3
INVESTMENT FLEET	$ 6,000	$16,000	$13,000	$ 6,000	$16,000	$13,000
FIXED CHARGE	2,000	3,200	2,200	4,000	6,400	4,400
GAS OIL ETC	4,300	3,900	2,500	8,600	7,800	5,000
TOTAL COST	6,300	7,100	4,700	12,600	14,200	9,400
REMAINING INVESTMENT	4,000	12,800	12,800	2,000	9,600	10,600
APPARENT DIFFERENCE BETWEEN TYPE 1 AND TYPE 3		$1,600			$3,200	

CHART NO. 6—SHOWS BASIC FIGURES FROM WHICH GRAPHS ON CHART NO. 7 ARE BUILT UP.

4. Cost of tires.
5. Life of tires.
6. Comparative consumption of gasoline and oil.
7. Comparative cost of maintenance of road for various type of trucks.

The answers to most of the above considerations are self-evident yet to what extent such affects the cost of transportation we do not know exactly, which gives one reason for this paper.

In order to avoid generalities and arrive at some definite conclusions, let us assume the following:

1. Grades not to exceed 4 per cent and road conditions similar to those found in the states of Indiana, Illinois, Iowa and Michigan.
2. Material to be hauled in proportion

TABLE II—ANALYSIS OF TON MILE COST.

Investment Single Unit.

	Type 1	Type 2	Type 3
Number of batches hauled	1	2	4
Weight of load in tons hauled	1.6	3.2	6.4
Cost of truck complete ready to operate	$1,000.00	$4,000.00	$5,000.00
License, one year	12.00	15.00	60.00
Liability and property insurance, 1 year	42.00	42.00	48.00
Fire and theft insurance, 1 year	20.00	50.00	60.00
Storage, 12 months	48.00	60.00	60.00
	$1,122.00	$4,167.00	$5,228.00
Interest at 7%	78.00	293.00	366.00
Total investment	$1,200.00	$4,460.00	$5,594.00
Average expenditure per year	700.00	1,793.00	1,844.00
Depreciated in	2 yrs.	3 yrs.	4 yrs.

Operating Costs—Gasoline 25c Gal., Oil 60c Per Gal.

	Type 1 Cents	Type 2 Cents	Type 3 Cents
Gasoline per mile truck operation	2.5	5.	6.2
Oil per mile	.5	.5	1.
Tires per mile	1.5	5.	6.
Repairs per mile	2.	3.5	4.
Total	6.5	14.	17.2

A typical Tarvia Road. 77th South Street, Salt Lake County, Utah.

Was Winter the Waterloo of Your Roads?

Has the Spring thaw turned the highways of your community into hub-deep bogs of mud—shut you off from town and neighbors?

Think what it would mean if you had roads like those pictured here. Winter's frosts, Spring's thaws, and Summer's suns have no effect on them.

For these are Tarvia roads, absolutely waterproof and frost-proof — firm, smooth, mudless and dustless every month in the year. Moreover the granular surface of a properly constructed and properly maintained Tarvia Road prevents skidding.

Your community — any community in fact — can afford these modern highways. Their first cost is comparatively low. Over a period of years Tarvia Roads prove so economical that the saving in maintenance makes it possible to increase the mileage of good roads in your community.

In many cases, by the addition of a Tarvia top, old macadam or gravel roads may be converted easily and economically into fine modern, traffic-proof highways.

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Carthage-Antwerp Road, Jefferson County, N. Y., another Tarvia Road.

Flourtown Road, Plymouth Township, Montgomery County, Pa. Treated with Tarvia.

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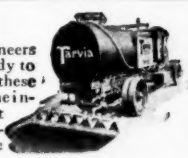
This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by anyone interested. If you will write our nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.



New York, Chicago, Philadelphia, Boston, Detroit, New Orleans, Birmingham, Kansas City, Bangor, Youngstown, Toledo, Columbus

The Barrett Company

St. Louis, Minneapolis, Richmond, Cleveland, Dallas, Baltimore, Cincinnati, Salt Lake City, Omaha, Pittsburgh, Atlanta, Houston, Denver

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batches to the mixer and not dumped on sub-grade.

3. The use of turntable to turn trucks at the mixer.
4. Gasoline—25 cts. gallon.
5. Lubricating oil—60 cts. gallon.
6. 10-hour day.
7. 150 working days per year.
8. 800 sq. yds. 7½-in. paving laid daily.

With these assumptions in the background, let us classify trucks of 2 ton capacity and less as light trucks. Let us depreciate them over 2 years of 150 working days each, thus making the average yearly expenditure on a truck one-half of its original cost, (one-half of $1,000) plus yearly expense of say $200, or a total of

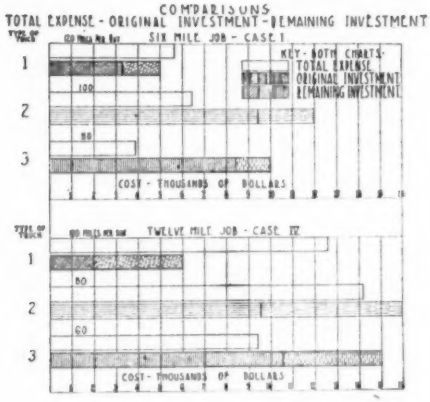

CHART NO. 7—GRAPHS SHOW COMPARATIVE TOTAL OPERATING COST, ORIGINAL INVESTMENT AND REMAINING INVESTMENT ON THREE TYPES OF TRUCK, FIRST, ON COMPLETION OF 6 MILE JOB OPERATING 120, 100 AND 80 MILES A DAY, AND SECOND, ON BASIS OF COMPLETION OF A 12 MILE JOB OPERATING 100, 80 AND 60 MILES A DAY.

$700. This class of trucks in the accompanying graphs is designated as Type 1.

Similarly, for the sake of comparison, let us classify trucks of 2 ton to 3½ ton capacity as medium trucks, depreciated over 3 years with average yearly expenditure of $1,793. These are designated in graphs as Type 2, while all trucks of over 3½ ton capacity will be classified as heavy trucks, depreciated over 4 years with average yearly expenditure of $1,844. These trucks are designated as Type 3.

Bearing these assumptions and classifications in mind, let us turn to graphic representation of the facts supported by Table I, "Elaborated Statistics of Chart No. 1 on basis of Daily Run of 50, 60, 70, 80, 90, 100, 110 and 120 Miles."

Chart No. 1 lists the statistics from which graphical presentations on Charts 2, 3, 4 and 5 are built up, while Chart No. 6 gives statistics on which the graphs on Chart No. 7 are built up.

From "Fixed and Operating Costs" as shown on Charts 5 and 6, it would seem that Type 3 Truck is the cheapest to use. Further analysis, however, shows this apparent showing to be as deceiving as is the thought of comparative loads hauled without comparison of number of trips made.

For sake of consideration, nevertheless, let us refer to Chart 5, where in case of "Fixed and Operating Costs" the showing seems to be in favor of Type 3 Truck and in view of these graphs and of the apparent saving of $3,200, as shown on Chart No. 6, consider the following:

(a) Can we afford to have but 3 trucks for handling 12 miles of work? Suppose one truck breaks down, we operate but 66 2/3 per cent efficient, whereas with one of six light trucks out of commission we operate 84 per cent efficient.

(b) Could we afford to take chances with heavy loads on highways which are being paved because they cannot take care of the present ordinary traffic?

(c) Can we afford to put one additional man every one-half mile on our sub-grade over and above those required to keep the grade in shape for light trucks? (This additional expense alone amounts to over $1,600 on a 12 mile job).

(d) Compare a jerky operation with 3 trucks of 4 batches each with the more continuous operation of 6 light one-batch units.

(e) Compare the investment of $15,000 in a fleet of 3 large trucks for 12 miles of work after which we still have $10,600 tied up in 3 units with an investment of $6,000 in 6 lighter trucks and, after 12 miles of work, but $2,000 tied up in 6 units.

There is no doubt that each type of truck has its place in the transportation problems of the highway contractor. It is only possible, however, to secure the best and most economical equipment for each job through an intelligent analysis of all factors involved in the operation of the truck.

In other words, let us make an accurate analysis of the Ton-Mile Cost as given in Table II.

The foregoing paper was presented at the the recent annual convention of the American Road Builders' Association.

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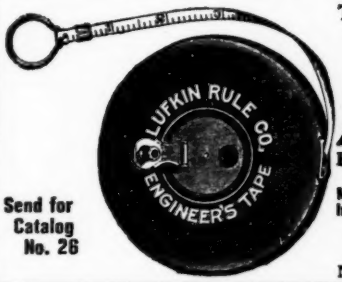

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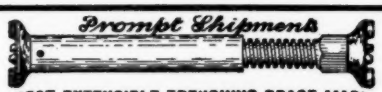

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SAUERMAN PORTABLE POWER SCRAPER delivering gravel to a small screening plant

EVINRUDE PUMP IMPROVEMENTS

The Evinrude Motor Company of Milwaukee announces a recent improvement in the bearing equipment of its centrifugal pump, hundreds of which are now used by contractors, engineers, municipalities, bridge builders, dredging companies and public service corporations.

To support the pump shaft at the lower end, a ball thrust bearing has been provided. This bearing supplants the lignum vitae plug heretofore used. After a six month's test it has been found that the ball bearing greatly increases the life of the lower bearings and also makes the pump operate more freely and effectively. This improvement is of special value because it can be installed in those pumps now in the hands of users.

PURCHASE OF MIETZ OIL ENGINE BUSINESS

The Charter Gas Engine Company of Sterling, Ill., U. S. A., announces the purchase of the entire "Mietz" Oil Engine (also known as "Mietz and Weiss") business, heretofore carried on at 128-138 Mott St., and 430 East 19th St., New York City, by the August Mietz Corporation and the Reliance Oil Engine Corporation. This effects a merger and consolidation, under one management, of two of the oldest and best known internal combustion engines in the world.

The "Mietz" Oil Engine was the pioneer Semi-Diesel oil engine of the world. The first "Mietz" Oil Engine was built in 1895 by Mietz and Weiss, and since that time there have been placed in service some 375,000-h.p. in all parts of the world. The "Charter" engine was the pioneer gasoline engine of the world, the first one having been built in 1886 and so far as is known it was the first commercially successful engine to use liquid fuel in the world.

The Charter Gas Engine Company is now moving from New York City to their plant at Sterling, Ill., all of the physical assets, comprising the "Mietz" Engine and in the meantime is filling repair orders from New York City, so that there will be no interruption in repair service to "Mietz" engine users.

It is announced that "Mietz" engine users will be able from now on to obtain prompt and reliable repair service for any "Mietz" Engine ever built.

A number of the personnel of the August Mietz Corporation organization have been engaged for work by the Charter Gas Engine Company insuring a thorough working knowledge of the manufacture of "Mietz" Engines.

In order to handle the added business properly, arrangements for additional floor space have been completed, whereby the area of the present Charter plant is almost doubled.

A NEW SUBGRADER

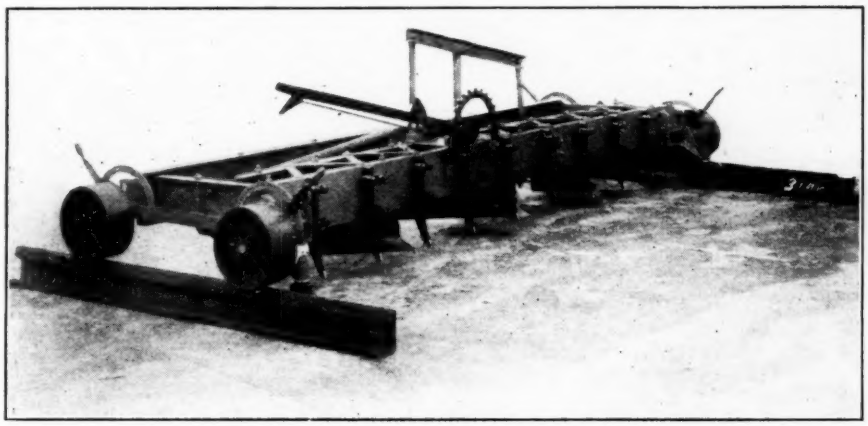
A new unit of paving equipment is the Lakewood steel subgrader illustrated herewith.

This steel subgrader is a development of the Lakewood wood frame subgrader, which has been used for the past several years and has proved of such advantage to both contractors and engineers that mechanical subgrading is rapidly becoming the standard method.

The steel subgrader has been developed to meet the demand for a heavier unit, and one which could be equipped with scarifying teeth on the front member to assist in breaking up the subgrade ahead of the blades. The wood frame subgrader will still be furnished, but the steel tool will be supplied to contractors desiring a stronger and heavier machine.

The purpose of the subgrader is to plane the subgrade to the exact depth for the road slab. It travels on the side forms and is pulled by a roller or tractor. Steel cutting blades, which can be adjusted so as to take very fine cuts, trim the subgrade to exactly the depth desired.

The machine will cut to either a flat or crowned subgrade and can also be adapted for the new Illinois design of subgrade, which provides for a slab considerably thicker at the edges than at the middle. A turntable pedestal allows the machine to be raised off the forms and turned in the middle of the road to allow the roller or trucks to pass.



NEW LAKEWOOD STEEL SUBGRADER.

Contracts Awarded

ROADS AND STREETS.

Ala., Birmingham—Jefferson Co. Bd. of Revenue let contracts for paving 14½ miles Roebuck-Chalkville rd. as follows: Southern Rds. Co., Birmingham, awarded contract at $101,230 for 1st 5 miles; Emulsified Company at $62,540 for next five miles and Sam E. Finley, Atlanta, at $54,720 for 4½ miles to St. Clair Co. line.

Ala., Carrollton—W. W. Thompson awarded contract to grade, drain and gravel surf. 23.6 miles road from Tuscaloosa Co. line to Carrollton, and to Ed. Pettus to construct bridges—total cost $373,667.

Ala., Montgomery—G. C. Goodrich, Albany, Ala., awarded contract for constr. of 20 miles road, at $200,183.

Ala., Sheffield—Southern Roads Co., Birmingham, Ala., awarded contract to pave 2nd St.—Atlanta Ave. to 27th St., to connect with intercity hwy. leading to Florence; Mitchell Bros. and J. K. Johnson, contract for sidewalks and san. sewers, total cost $75,000.

Cal., San Bernardino—J. F. Knapp, Turlock, (Box 442, Long Beach) award. contract for impvt. of Hellman Ave. at $109,600 approx. I mile grading and paving with 5-in. conc. paving; constructing curbs, walks and retaining walls; Lienau & Levering, contr. for paving Orange St.—A to B Sts.—at 13.5c. for paving and 16c. sq. ft. gutters; A. W. Gardner contract at 13.5c. sq. ft. for paving intersect. of 8th and H Sts. at 13.5c. sq. ft.

Cal., Santa Monica—Kneen Paving Co. Dudley Bldg. Santa Monica, awarded contract for paving and constructing sewers, lights, walks and curbs in Wilshire Blvd. Sq. Tr., at $143,311; also contract for paving Arizona St., at $91,755.

D. C., Washington—Cranford Co. 2620 E St., N. W., Washington, awarded contr. by Dist. Commrs. for 140,000 sq. yds. cement conc. roadways, at $500,000.

Fla., Pensacola—Hancock Bros. Mobile, Ala. awarded contract to grade, construct draing. structs., lay base and wearing surf. on 5 miles Rd. No. 1 at $138,556.

Fla., Sebring—DeLaney & McCormick, awarded contract for completion of 5.75 miles Lake Annie-Josephine Creek link of State Rd. No. 8, Highlands Co. bet. Lake Stearns and Josephine Crk., at $90,000.

Fla., Winter Garden—J. B. McCrary Co., Atlanta, Ga. awarded contr. for paving here at $200,000.

Ill., Springfield—Dept. Public Wks. & Bldgs. Springfield, let following contracts for concrete paving: 1. 5.82 miles, Route 26, Sec. 1, Ogle-Stephenson Co. 2. 6.06 miles Proj. 47, Sec. 64, St. Clair Co. 3. 2.99 mi. Proj. 47, Sec. 65 Monroe Co. 4. 3.24 mi. Proj. 49, Sec. 13, Kankakee Co. 5. 5.57 mi. Proj. 49, Sec. 14, Kankakee-Livingston Co. 6. 7.75 mi. Proj. 49, Sec. 15, Livingston Co. 7. 1.59 mi. grading Route 1, Sec. 16a Lawrence Co. to R. F. Conway Co., 133 W. Washington St., Chicago. (1) $114,165; (4) $73,375; (5) $124,894; (6) $144,752; Keely Bros. Contg. Co., 2100 State St., E. St. Louis; (2) $118,-167; (3) $49,833; Dees Bros. Oblong, (7) $70,597.

Ind., Indianapolis—Following contracts for road work let by State Hwy. Comn.: Fed. Aid Proj. 16, Sec. 1, Vanderburg Co. 6.471 miles, to Jno. B. Shelby, Lebanon, Ind. one course conc. pavement at $123,257; FAP 44, Sec. B, Allen Co., 6.063 mi. to Williams & Baldwin Co. Cleveland Heights, Ohio; concrete paving, at $126,907; FAP 48, Sec. A, Laporte Co. 6.950 miles bitum. conc., at $139,823; FAP 44, Sec. A, Whitley and Allen Cos., 7.780 miles, conc., at $138,620, to Williams & Baldwin Co., Cleveland Heights, O.

Ind., Princeton—F. H. Hull, Tipton, awarded contract for crushed stone surfacing 5 miles, H. W. Barrett Rd., and 40,112 ft. Graper Rd. both 16 ft. at $40,873 and $61,469 respectively.

Ia., Le Mars—Moore-Young Constr. Co., Waterloo, awarded contract for paving about 78 blocks, including gutter, curb and grading, at $330,000.

Ia., Tipton—Wm. Horrabin Constr. Co., Iowa City, awarded contract on bitulithic paving at $113,216.

Ky., Ashland—Hunt-Forbes Constr. Co., Ashland, awarded contract for paving in Park Hill Addn., at $110,000; 8,437 sq. yds. brick on conc. base; 19,977 sq. yds. bitum. on pit-run slag base; Brewer & Brewer Co., Chillicothe, Ohio, awarded contract to build 1½ miles Bellefonte road from Russell Rd. to Co. Country Club.

La., Baton Rouge—E. R. Morris, Lake Charles, awarded contract for constr. of 5 miles Vinton-Orange Hwy., in Calcasieu Parish (part of the old Spanish Trail) from Vinton to Toomey, at $63,554; Hogsett & Co., East Point, awarded contract for constr. of approx. 18 miles rd. on Tallulah-Delta Hwy. at $213,249.

Md., Baltimore—Baltimore Asphalt Blk. & Tile Co. 1320 N. Monroe St. awarded contract to pave Eutaw Heights Ave. and streets northeast from Clifton Park, at $86,691.

Md., Baltimore—P. Flanigan & Son, Hartford Rd. awarded contr. for repaving with sheet asph. St. Paul St.—North Ave. to 25th St., and North Ave.—Charles St. to Greenmount Ave. at $150,000.

Mich., Monroe—C. M. Gray, Waterville, Ohio, awarded contract for 4½ miles macadam rd. by Monroe County Rd. Commrs., at $90,526.

Mich., Saginaw—Following contracts let by Saginaw Co. Rd. Comn. Sec. A, Assessment Dist. Rd. 55, Frankenmuth Twp. Saginaw Co. 3.021 miles, 16 ft. waterbound macadam surf. treated, to Bennett

& Crane, St. Charles, Mich., at $58,554; Alex. Jeffrey, Saginaw, awarded contract for Dist. Rd. 56, Thomas Twp. 4.308 miles, 12 ft. stone macadam surf. treated, at $71,397; Westphal, Leach and Bedtelyon, Montrose, Mich. for Dist. Rd. No. 35, Birch Run Twp. Saginaw Co., 2.975 miles, 12 ft. all gravel surf. at $22,585. Alfred Folks, award. contract by Washtenaw County Rd. Comn. for Dist. Rd. 13, State Reward gravel rd. Cl. B-9, 3.761 miles, at $40,472.

Miss., Belzoni—John Gerkins & Co., Pensacola, awarded contract by Humphreys County Bd. of Supvrs., for 7 miles conc. road from Sunflower Co. line no. of Isola toward Belzoni, at $201,366 and for Isola brdg. at $16,744.

Miss., Magnolia—Smith Bros., Dallas, awarded contract by State Hwy. Dept., Jackson, to build 2.8 miles brk. surf. on conc. base road bet. Summit and McComb Pike Co. Proj. 136, at $124,000.

Neb., Tekamah—Bauer & Johnson Contr. Supply Co., 78th and Dodge Sts., Omaha, awarded contract for paving, curbing and constructing sidewalks, grading, etc., at $127,000. Contract for tile to Lillie Tile Works, Fremont.

N. J., Salem—Weldon Contracting Co., Broad St., Westfield, awarded contract for paving 33,350 sq. yds. macadam at $90,348.

N. J., Spring Lake—J. F. Burke Constr. Co., 309 Park Ave., Plainfield, awarded contract for impvt. of E. Lake Dr. at $104,228.

N. Y., Buffalo—Rock Asphalt & Constr. Co., Morgan Bldg., award. contract for paving various streets, at $128,751; Wyoming Ave. to H. P. Burgard Co., 1968 Fillmore Ave., at $12,175—all standard asph. on conc.

N. C., Burlington—McGuire & Rolfe, Richmond, Va., awarded contr. to grade and pave with asphlt. abt. 50,000 sq. yds. streets, including Maple Ave. and Holt St., also lay 11,000 lin. ft. comb. curb and gutter and install water and sewer mains, at $78,386.

N. C., Charlotte—Noll Construction Co., Lexington, N. C., awarded contract for 3 road projects as follows: 4.3 mi. Cornelius to Beatty's Ford Bridge; 4 miles 32nd St. and Old County Home rd.; 4 miles Derita Rd.—City limits beyond Derita; all conc. base with asph. top at $257,344.

N. C., Enfield—Robt. G. Lassiter & Co., Raleigh, N. C., award. contract to pave about 2 miles of streets, at $135,000.

N. C., Greensboro—I. F. Grantham & Co., award. contract to lay sidewalks on N. Elm St.—Church to Price Sts., at $1.64 sq. yds.; Murray Const. Co., Knoxville, Tenn., awarded contract to pave 100,000 sq. yds. asphalt paving in various sections of city on Walker Ave. and on 30,000 sq. yds. conc. paving, at $600,000.

N. D., Wahpeton—W. E. Kennedy, Fargo, awarded contract for paving, curbing and guttering 37 blocks (rock concrete) at $190,136.

Ohio, Bexley—(Columbus, P. O.)—Grand-Boulton Co. Central National Bank Bldg., Columbus, award. contract for grading, curbing and laying 8-in. water main, making necessary sewer connections and paving with asph., 2,200 ft. Ardmore Rd. 24 ft., $44,366; 550 ft. Seneca Pl., 24 ft. $39,836; 350 ft. Seneca Pl. 24 ft. $8,432; 2,000 ft. Fair Ave. 36 ft. roadway with 18 ft. parkway in center, at $49,443.

Ohio, Columbus—Dept. Hwys. & Public Works, awarded contracts for grading, bridging and paving roads in following counties: Crawford Co. Sec. C, Bucyrus-Crestline Rd. 1.69 miles, asph. macadam oil, to Losey Rd. Constr. Co. ,Kenton, at $46,580; Cuyahoga Co. Sec. A, Solon-Willoughby Rd. and Sec. B-1 Chagrin Falls-Cuyahoga Falls Rd. 2.52 mi. Warrenito bitulithic and brk. to Ohio Contracting Co., Elyria, at $144,847; Goauga Co. Sec. J. Chagrin Falls-Greenville Rd., 2.182 mi. brick to J. A. Westrick, Napoleon, at $41,437; Meigs Co. Sec. H. Pomeroy-Athens Rd. 4.009 mi. rein. conc. to S. A. Palmer, Marietta, at $122,647; Mercer Co. Sec. H-2, Celina-Greenville Rd., 4.28 miles rein. conc. to R. Doaust, Defiance, at $113,295; Sandusky Co. Sec. S-2, Lima-Sandusky Rd. 2.349 mi. sheet asph. on conc. to Modern Constr. Co., Fremont, at $94,620; Huron Co. Sec. K and J-1, Bellevue-Norwalk Rd. rein. Conc. brdg. to W. A. Yeagle, Clyde, at $15,-646; Lorain Co. Secs. D and E, Cleveland-Elyria Rd. constructing culvt. to Elyria Construction Co. 220 Elyria Blk., Elyria.

Ohio, Shaker Heights—(Cleveland, P. O.)—Cleveland-Trinidad Paving Co., The Arcade, awarded contract for grading and asph. paving E. 150th St., Helena Ave., N. Midland Blvd., Milverton and Warwick Rds., at $148,338.

Pa., Ford City—McCrady Bros., Sixth Ave. Braddock, awarded contract for grading, paving and curbing 5th and 6th Aves., 5th to 14th Sts., inclusive, at $282,593.

Tex., Beaumont—Uvalde Rock Asphalt Co., Cline, Tex., awarded contract to pave with rock asphalt, Pine, Mariposa, Fannin and Railroad Sts., at $209,-902.

Tex., Corpus Christi—Smith Bros., Dallas, Tex., awarded contract for 2 sections of roads in Nueces Co: 10.97 mi. on S. H. No. 12 at $112,022 and at $127,145 for 11.71 miles on S. H. No. 12.

Va., Richmond—Henry W. Roberts, Clara, Md., awarded contract for 6 miles conc. road so. from Tasley, Proj. 221, at $198,812.

Wash., Olympia—F. X. McLellan, Lyon Bldg., Seattle, awarded contract for 4.4 miles road impvt. from Kalama to Carrolls, at $155,865; S. A. Moceri, Seattle, awarded contract for paving 6.37 miles Pacific Hwy.—Carrolls no. to Kelso—at $221,417.

W. Va., Wayne—White & Rich, awarded contract to complete 6½ miles of road in Lincoln Dist. on Tug River, at $143,124.

Wis., Elkhorn—R. R. Birdsall, Racine, awarded contract for rd. work in Walworth Co. at $223,185 on Lake Geneva-Genoa Jct. Rd.

Wis., Fond du Lac—Cherney Constr. Co., Francis Creek, awarded contract for conc. surfacing, etc., on Fond du Lac-Ripon-Green Lake Rd., at $141,058; Ripon-Oshkosh Rd. and Waupon-Brandon Rd. to A. J. Kramp, Berlin, at $105,872 and $70,869.

Wis., Hartford—Manitowoc Constr. Co., 826 S. 8th St., Manitowoc, awarded contract for paving Union, State, Main, Branch and Grand Streets with 2-course conc, at $125,395.

Wis., Jefferson—Following contracts let by Jefferson Co. St. Rd. & Bridge Comn. for grading and surfacing: Ixon-Watertown Rd. to McGucken Construction Co., 92 Mason, Milwaukee, at $95,789; Whitewater-Ft. Atkinson Rd., to J. P. Connell, Janesville, at $140,669; Ft. Atkinson-Cambridge Rd., to F. Doherty, 735 47th St., Milwaukee, at $191,110.

Wyo., Casper—Scott & Curlee, Sterling, Colo., awarded contract for sidewalks and curb, at $122,-816.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Fresno—Merced Constr. Co., Merced, award. contract for constr. of concrete and vit. pipe sewer in Stanislaus and H Sts., at $20,878.

Cal., Lodi—Davis-Heller-Pearce Co., Delta Bldg., Stockton, awarded contract for constr. of sewage disp. plant, at $83,169.

Cal., Santa Ana—Deward & Cobham, Granger Bldg., San Diego, awarded contract for constructing ocean end of joint outfall sewer line, at $43,000; screening work to Teget & Cox, 222 Harvard Pl., Ontario, at $10,900.

Ont., Toronto—J. L. Jerou, 90 Curzon St., award. contract for relief sewers No. 1 and No. 2, at $130,-807.

Ill., Arthur—James & Shinn, Mattoon, awarded contract for sewer impvts., at $24,846.

Ill., Dwight—C. D. Reeber, Dwight, awarded contract for sewage disp. plant; $25,000, Engineer's est.

Ill., Villa Park—H. Reese, Quincy, awarded contract for sewerage system. Engr's. est. $100,000.

Iowa, Clinton—W. B. Carter, United Bank Bldg., Sioux City, awarded contract for sewers in Sewer Dist. 7, bet. Main and Commercial Sts., at $49,879.

Iowa, Glidden—Gjellefald-Chapman Constr. Co., Forest City, awarded contract for 23,100 lin. ft. 8-in., 4,150 ft. 10-in., 4,410 ft. 12-in., and 420 ft. 15-in. sewers, 75 manholes, etc., at $40,744; disp. plant to Sieg Constr. Co., Waterloo, at $8,423.

Ill., Rockford—P. O. Lary & Son, Laporte, Ind., awarded contract for sewers in 14th Ave. Engineer's est. of cost, $25,000.

Iowa, Walnut—Welp & Zigrang, Bancroft, awarded contract for san. sewerage sys., at $21,-638; Gjellefeld-Chapman Constr. Co., Forest City, awarded contract for sewage disposal plant, at $9,438.

Kans., Ft. Scott—Ammerman & Snyder, Ft. Scott, awarded contract for san. sewer in Dist. 8; also East Side Dist. 2, at total cost of $54,041.

Mass., Boston—J. P. Dwyer Co. awarded contract

for piping and other equipment for new boilers at Calf Pasture pumping station, at $31,500.

Mex., Mexicali—Pioneer Truck & Transfer Co. (T. R. Yglesias, Prop.) awarded contract at about $41,000 to install sewer systems in residential section known as the "Governor's Palace" district. Wk. is being done under Governor Lugo's impvt. program which totals many hundreds of thousands of dollars. Present contract involves 31,000 lin. ft. sewer, 50 manholes, flushing tanks and septic tanks in old river bed.

Mich., Detroit—Whitney & Hollinger Co., 408 Detroit Savings Bk. Bldg. for 11,000 ft. 6, 8 and 10-in. crock sewers in Morningside subdivision, awarded contract to O. Schultz, care of owner, at $25,000.

Mich., Springwells—J. Porath, 745 Griswold St., Detroit, awarded contract for sewers in Sec. 25, Barclay Ave., at $35,667; Sec. 26, Sec. 28, 29, 30 to G. R. Cooke, 1260 Penobscot Bldg., Detroit, at $43,951, $47,169, $65,415, and $65,353, respect.; Sec. 27 in Colson Ave. to R. Mercier, 5435 Wesson Ave., Detroit, at $107,345; Sec. 32, to P. Frandsen, 1167 Sellick Ave., Kenosha, Wis., at $25,986; Sec. 31, 33, to Hammend & Co., 4612 Woodward Ave., Detroit, at $14,217 and $36,071, respectively; Sec. 35, Rome Ave., to Lennane and McIlvenna, 1205 Book Bldg., Detroit, at $16,197.

Minn., Lake City—Christensen & Axelsen, Clear Lake, Iowa, awarded contract for sewers here at $99,080; 59,303 ft. 8, 12-in.; manholes, flush tanks, appruts. Steam sewers: 6,600 ft. 8, 12-in., 11 manholes, extra work on 5 manholes, 65 storm water inlets, 266 ft. 8-in. and 2,108 ft. 10-in. inlet connections.

Minn., Minneapolis—Red Wing Sewer Pipe Co., Red Wing, awarded contr. for vit. clay sewer pipe, various sizes, at abt. $38,000.

Mo., Harrisonville—J. O'Neil, 119 4th Ave., Leavenworth, Kans., awarded contract for rein. conc. disp. plant, 45,000 ft. 6, 12-in. sewers, trench work, flush tanks, etc., $47,395.

Mo., Columbia—C. J. McCoy Constr. Co., Emporia, Kans. awarded contract for constr. of sewer system here at $44,475.

Mo., Neosho—Queal Constr. Co., Herington, Kans. awarded contract for san. sewers in Sec. 1, (public sewers) at $53,087; Dist. sewers (Dist. 1) $19,481, Dist. Sewers (Dist. 2) $2,671 and Dist. sewers (D. 3) $171,299.

Mo., St. Louis—Fruin-Colnon Constr. Co., Merchants-Laclede Bldg., awarded contract for sewer in Manchester Sewer Dist. 2, at $26,809; Harlem Creek Sewer Dist. 20, to Frazier-Davis Constr. Co., Arcade Bldg., at $26,245.

Neb., Lincoln—Phelps & Sons, Knoxville, Ia., awarded contr. for constr. of sewers. Engr's. est. $175,000.

N. M., Artesia—R. M. Irick & Sons, Plainview, Tex., awarded contr. for 11,476 lin. ft. 6-in. vit. pipe $0.26; 21,012 lin. ft. 8-in., $0.42; 2,475 ft. 10-in., $0.58 and $3,656 ft. 12-in., $0.75; 10 flush tanks, $90; 99 manholes, $92; disp. plant with septic tank, sludge bed, etc., $5,000—total $24,457; also 1,025 ft. 6-in. c.i. water mains, $1.40 ft., 5,970 ft. 4-in., $1.02, etc.—total, $9,920.

N. Y., St. George—J. W. Murphy, 8866 26th Ave., Brooklyn, awarded contract for temp. san. sewer in Sand Lane, etc. at $59,645.

N. Y., Scottsville—F. W. Hamilton, Rochester, awarded contract for sewerage system, at $54,000.

N. C., Greensboro—Murray Construction Co. awarded contract for following sewer work: at $3,904 for Contr. No. 3, at $5,826 for Contr. No. 4, at $453,500 for Contr. No. 5.

Ohio, Akron—T. E. McShaffrey Constr. Co., 171 S. Forge St., awarded contract for 2,930 ft. 39-in. and 340 ft. 45-in. brick sewer, Ohio Canal Interceptor, at $76,353; 1,400 ft. segmental blk. and vit. sewer in W. North St. to S. Erslan, 370 Bowery St., at $12,707; 3,705 ft. vit. and brk. sewer in S. Arlington St. Contr. 2, 5th Ave. trunk, to T. D. McShaffrey Constr. Co., City, at $16,501; 4,180 ft. segmental blk. sewer in Bye St. Contr. 1, to Iafornaro Constr. Co., 2218 Murray Hill Rd., Cleveland, at $62,947; 3,855 ft. segmental blk. and vit. sewer in Bye St. Contr. 2, to C. Ruhlin, 18 Metropolitan Bldg., at $54,530; 860 ft. blk. sewer in W. Market St., to M. O. Toole, 155 Gale St. at $30,005.

Ohio, Columbus—L. O. Jones, 707 Grove St., awarded contract for 1½ miles 18, 48-in. storm and san. sewer in Torrence Run, at $30,164.

Ohio, Dayton—Murray & Dill, 18 Cambridge Ave., awarded contract for 14,770 ft. 8, 10-in. vit. sewer in Westwood Sewer Subdist. B, at $29,566.

Pa., Phila.—Following contracts for sewers let: In Ashdale St. to A. Pascuzzi, Lincoln Bldg., at $14,564; Charles St. to O'Neill Co., 127th St. & Hermaid Lane, at $39,985; Germantown Ave. and Haines St. to A. J. Ellis, 5724 N. Marshall St., at $6,882; Pratt St. and Grays Ave. to A. DeVite, 1721 Hicks St., at $5,452 and $5,698 respectively.

S. C., Greenville—City Construction Co. awarded contract for sewer construction at $19,442.

Wis., Milwaukee—G. E. Zimmerman, 3402 Grand Ave., awarded contract for 4,200 ft. 42-in. rein. conc. intercepting sewer in various streets at $134,-179.

Wis., Milwaukee—A. H. Prange, 101 Campau Ave. Grand Rapids, awarded contract for intercepting sewer in Scott St. at $94,560.

WATER SUPPLY AND PURIFICATION.

Cal., Los Angeles—Baker Iron Works, 912 N. Broadway, awarded contract for furnishing 10,000 ft. riveted sheet steel pipe, f.o.b. trench side, item 1, at $5.16, and item 2, 6c. lb., added for fittings.

Ont., Port Credit—National Equipment Co., Ltd. No. 1 Wabash Ave., Toronto, awarded contract for new water wks. sys. for the Mississauga Golf Club, at approx. $10,000.

Colo., Walsenberg—City will lay, by day labor, 5 miles cast iron Cl. B pipe, Est. cost $150,000. D. Cory, Engr.

Fla., Zephyrhills—E. G. Ladd, 61st St., Jacksonville, awarded contract for water works impvts., at $26,353. Contract includes 200 tons cast iron pipe, 10,000 ft. galv. pipe, one 75,000 gal. tank, 110 ft. tower, 2 centrif. pumps, engines, pumping station, buildings and well.

Ill., Carlyle—Illinois Constr. Co., Springfield, awarded contract for filtration plant here: Item 1, $1,232; 2, $6,632; 3, $1,268; 4, 2,063; 5, $365; 6, $1,659; 7, $3,081; 8, $180; 9, $651; 10, $128; 11, $273; 12, $1,210; 13, $462; 14, $19,305.

Ill., Marengo—Hamilton Bros., Ann Arbor, Mich., awarded contr. for 6,000 ft. 4-in. and 1,200 ft. 6-in. mains, 4,250 ft. 8-in. and 3,200 ft. 10-in. sewers, at $20,202.

Iowa, Des Moines—Des Moines Steel Co., 5th and Tuttle Sts., Des Moines, awarded contract for 5,000 ft. 4-in. Class B cast iron main laid under 5 ft. cover, at $0.90; 11,000 ft. 6-in. c.i. pipe at $1,20; 50,000 gal. steel tank on 100 ft. tower at $4,791; conc. for foundations $26 per c.y.; deep well pumping equipt., at $2,793; pump house, $835—total, $29,-200.

Kans., Republic—Following contracts let: Installing water wks. to E. K. Ladd & Co., 3229 Harrison St., Kansas City, at $18,258; 50,000 gal. tank on 60-ft. tower to Chicago Bridge & Iron Co., 608 Dearborn St., Chicago, at $4,500; pumpg. equipt. to Terry, Cowan & Smith, Davidson Bldg., Kans. City, Mo., at $1,725.

Md., Baltimore—J. Robertson Lead Works, 827 S. Howard St., awarded contract for furnishing pig lead, at $26,550.

Md., Baltimore—Carozza-Rowe Constr. Co., Gilmore Street near Edmonson Ave., awarded contract for constr. of filter beds at the Montebello plant with capy. of 96,000,000 gals. per day, at $1,-070,000.

Mich., Ferndale—L. Kovorkian, Pontiac, awarded contract for laying 7,720 ft. 10 and 12-in. cast iron mains, together with backfilling, at $15,000.

Minn., Lake City—Litchfield Drainage and Constr. Co., Litchfield, awarded contract for water mains at $58,943; sewers to Christensen & Axelsen, Clear Lake, Ia., at $99,080.

Minn., Minneapolis—Contract for 40,000 ft. 6-in., 16,000 ft. 8-in. and 10,000 ft. 12-in. bell and spigot c.i. pipe, let to Am. Cast Iron Pipe Co., Acipco St., Birmingham, Ala., at $60,000; 110 tons special water castings to Am. Brake Shoe Foundry Co., 37th Ave., NE and University Ave., at $8,000; 400 tons special sewer castings to Crown Iron Wks. Co., Tyler St., at $25,000.

Minn., St. Paul—U. S. Cast Iron Pipe and Foundry Co., American Trust Bldg., Birmingham, Ala.,

awarded contr. for 30 in. and 42 in. cast iron pipe, at $189,000; So. Park Fndry. & Mach. Co., 23 E. 6th St., contr. for 250 6-in., 35 8-in. 16 16-in., 5 20-in. and one 24-in. hube end, nut-operated, nonrising steam valves, etc. for Water Dept., at $5,415; Iowa Valve Co., 727 Pillsbury Ave., St. Paul, contract also for furnishing part of above material at $5,235.

Minn., St. Paul—Gamon Meter Co., 282 South St., Newark, N. J., awarded contract for furnishing disc type water meters, at $26,675; Kennedy Valve Mfg. Co., E. Water St., Elmira, N. Y., contract for hand-operated gate valves, at $6,892; St. Paul Fdry. Co., Como Ave. and Mackubin Sts., contr. for 100 tons special castings at abt. $150 per ton; one 12,000 gal. steel gasoline tank with pump, etc. to E. R. Tarnoski, 328 Metropolitan Bank Bldg., at $750.

N. Y., Buffalo—U. S. Cast Iron Pipe & Foundry Co., 957 E. Ferry St., awarded contract for furnishing cast iron pipe and specials, at $95,148; 341 valves to Rensselaer Valve Co., Ontario St., Troy, at $109,687; 100 hydrants to Howard Iron Wks., 287 Chicago St., at $82.75 each; 100 hydrants, to R. D. Wood & Co., 300 Chestnut St., Philadelphia, at $66.30 each.

N. C. Charlotte—Lynchburg Foundry Co., Lynchburg, Va., awarded contract for 47,000 ft. c. i. pipe and fittings for extensions to City water lines, at $43,605.

N. C., Greensboro—Paul N. Howard, Raleigh, awarded contract for installation of approx. 7 miles water pipe, also installation of about 5 miles sewer lines, at $40,783.

Ohio, Cleveland—Dadded & Kariel, 314 Eagle Ave., awarded contract for 8,398 ft. 6 and 8-inch cast iron mains for Impvt. 23 of Co. Sewer Dist., at $37,342.

Ohio, Cleveland—Langahan Constr. Co., Marshall Bldg., awarded contract for 16,160 ft. 6 and 8-in. cast iron mains in Impvt. 16 C of Co. Water Dist., at $40,197.

Ohio, Dayton—F. Krumjoltz, Springfield, award. contract for mains in lower Westwood Dist., at $131,938; Crumley, Jones & Crumley, 2301 Concord St., Cincinnati, awarded contract for mains in higher Lakeside Dist., at $79,861; C. F. Smith & Son, 54 Davies St., lower Lakeside Dist., at $32,131.

Ohio, Wellsville—A. W. Hinaman, Canton, Pa., awarded contract for earthen reservoir and dam at $110,333; furnishing 300 ft. 30-in., 11,000 ft. 16-in., 52,744 ft. 16-in. and 78 ft. 4-in. cast iron pipe to U. S. Cast Iron Pipe and Foundry Co., 412 Oliver Bldg., Pittsburgh, Pa., at $56,029; Allison-Harris Construction Co., E. Liverpool, awarded contract for laying the pipe, at $53,428.

Okla., Poteau—J. S. Terry, Poteau, awarded contract to construct reservoir and make extensions to water mains, $45,000 bonds available.

Okla., Wynnewood—Sherman Machine Co., 18 E. Main St., Okla. City, awarded contract for 150,000-gal. elevated tank, 2 miles pipe line, 2 wells, 350 h.p. power plant elec. distribution sys. and transmission line, etc., at $61,263.

Tex., Dallas—Randolph & Steelsmith, Dallas, awarded contract for water well to Trinity Sands in Oak Cliff, at $43,606.

Tex., Ft. Worth—American Pipe Co., Birmingham, Ala., awarded contract for cast iron pipe for extension of water distributing system at $400,000. Other impvts. will be made at cost of $1,100,000. $1,500,00 bonds available.

Utah, Price—D. C. Dunbar Co., 325 Walker Bank Bldg., Salt Lake City, awarded contr. for 160 tons 4 and 6-inch cast iron pipe, etc., at $16,000; 460 tons 8 and 10-inch cast iron pipe to U. S. Cast Iron Pipe Co., Dooley Bldg., Salt Lake City, at $30,360.

Va., Cape Charles—Chicago Bridge & Iron Works, awarded contract for constr. of tanks and tower at $6,935; Stevens-Etz Montague Co., Inc., Norfolk, award. contract for all other work connected with the water wks. impvts., at $30,711.

Wash., Aberdeen—Central Foundry Co., Rialto Bldg., San Francisco, awarded contract for 5,000 ft. 16-in. cast iron mains from reservoir to feeders, at $44,754.

Wis., Milwaukee—Simplex Valve & Meter Co., 5722 Race St., Phila., awarded contract for furnishing and installing three 42-in. Venturi tube meters for Riverside Pumping Sta., at $7,050; City will also lay by day labor 16,370 lin. ft. 6-8-in. mains in various thoroughfares, at $25,000.

Wis., Milwaukee—U. S. Cast Iron Pipe & Fndry. Co., 122 S. Mich. Ave., Chicago, awarded contract for furnishing 3,000 tons 6, 16-in. Cl. C pipe, at $159,700; 100 tons special castings to American Cast Iron Pipe Co., 38 S. Dearborn St., Chicago, at $9,500.

Prospective Work

ROADS AND STREETS.

Cal., Los Angeles—Ord. of intention adopted by City Council for impvt. of Windsor Blvd., Beechwood Dr., Plymouth Blvd. and Irving Blvd. bet. Rosewood Ave. and Beverly Blvd., by grading and paving with 1½-in. Warrenite-Bitulithic wearg. surf. on 3½-in. bitum. base; constructing cement curb, 50 ft. walks, conc. gutter, catch basin, 27 vit. pipe hse. sewers.

Cal., San Diego—San Diego County voted $600,000 bonds for constructing 57 miles of highway. E. R. Childs, Co. Surv.; B. Allen, Clk. of Bd. of Supvrs.

D. C., Washington—U. S. Bureau of Pub. Roads, Washington, D. C., has approved plans for 12.02 miles 18-ft. bituminous macadam pavement on Corpus Christie-Bishop Rd., Neuces Co., FAP 340, FAP 340. Calvin E. Cooke, Co. Engr., Corpus Christie, Texas.

Fla., Deland—City considering 10 miles additional street paving and impvt. of sewer and electric systems. Est. cost $320,000.

Fla., Inverness—Citrus County Commrs. plan to construct 10 hard-surfaced roads and have approprited funds as follows: St. Rd. 5—Dunnellon to south county line, via Holder, Hernando, Inverness and Floral City, $375,000; Crystal River to Inverness via Iccanto, $225,000; Homososssa to Crystal River, $24,000; Crystal River to Inglis, $20,000; Red Level to Dunnellon, $24,000; from Camp's Dam to Crystal River-Dunnellon Rd., $3,000; Maple to Crystal River to Inverness Rd., $6,000; Holder to Stoke's Ferry, $10,000; Floral City to Weed's Landing and Istachatta, including ¾-mile in Floral City, $22,000; Inverness to Rutland Ferry, $16,000.

Fla., Jacksonville—Duval County Commrs. plan to build macadamized or other hard surf. rds. in County; will vote May 15th on $2,550,000 bonds; also construct bridges across Trout Creek and McGirts Crk.; vote May 15th on $450,000 bonds.

Fla., St. Augustine—St. Johns County Commrs. plan to build 6 roads as follows: 8.4 miles Elkton-Tocoi; 14 miles Tocoi Rd.—Tocoi to St. Augustine; 3 miles Spud; 6.25 miles from Hastings to Putnam Co. line; 2.5 miles extend. Hastings Blvd. to Flagler Co. line; road to and thru Sampson. Will vote April 24th on $500,000.

Fla., St. Petersburg—Pinellas Co. plans to improve 90 miles road, including 7 roads as follows: 30 miles Seminole Rd.—Davista to Pasco Co. line; 7 miles from Ozona to Hillsborough Co. line; 12 miles from Clearwater to Oldsmar; 15 miles from Indian Rocks to Safety Harbor; 13 miles Haines Rd. from St. Petersburg to Largo intersection; 6 miles Gandy brdg. approach from Largo intersect. to bridge head; 6 miles Gandy bridge approach from 4th St. Will vote May 2nd on $3,275,000 bonds. C. E. Burleson, Co. Engr.

Ky., Hartford—Ohio County considering bldg. Owensboro Rd. to Daviess Co. line connecting with Hartford Rd. $300,000 bonds voted.

Md., Baltimore—State Roads Commission, 601 Garrett Bldg., Baltimore, Md., plans bldg. 39 roads in various counties.

Mich., Holland—City has under consideration various paving projects which will cost approx. $400,000. Amounts for the different impvts. are as follows: College Ave., $108,713; Columbia Ave., $102,796; 14th St., $113,671; Central Ave., $14,873; Central Ave., $44,100 and River Ave., $8,565.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Minn., Little Falls—Will soon ask bids for Jobs 306, 2308, in Morrison County; 3½ miles grading and 5 miles grading. Co. Engr., J. E. Viner; Leo. J. Billstein, Co. Aud. Also making plans for constr. of 3 mi. of road on State Rd. No. 5 betw. Little Falls and Bowlus.

N. C., Raleigh—State Hwy. Comn.,—F. Page, Chrmn.—has authorized 41 road projects as follows: 149, Hertford Co., 14 miles from Murfreesboro to Virginia State line; Route 485; 222, Duplin Co., 10 miles Duplin Co., etc.

N. C., Rutherfordton—Town plans additional impvts. and contemplates issuing $150,000 bonds as follows: $25,000, street; $75,000, sewer; bldg., $50,000.

Okla., Okla. City—State Hwy. Comn.,—F. G. Simmons, Engr.—contemplates bldg. 50 miles highway in Stephens Co. near Duncan; high type pavement; Projs. 99 and 102. Est. cost $1,800,000 available.

Okla., Sapulpa—Creek County, Tiger Twp., plans hard surfacing about 21 miles road from Payne Co. line to Mannford Twp. line thru Drumright and Oilton; also another section from Oilton to Yale. $300,000 bonds voted.

Ore., Portland—State Hwy. Commrs. will call for bids immediately for practically $800,000 worth of highway work. Plans approved for $550,000 worth of fed. forest highway work in which State will cooperate. Bids for this will soon be asked by U. S. Bureau of Public Roads.

Ore., Roseburg—County Court recently adopted 26 rd. projects for present year, totaling $109,180.

Pa., Erie—Erie Co. contemplates paving 23 miles Corry-Waterford Road. Est. cost $500,000. F. Hill, Co. Engr.

S. C., Walhalla—$100,000 bonds voted by Oconee Co., for road impvts.

S. D., Mitchell—Will call for bids on 29 blocks grading, curb, gutter and paving. F. McGovern, City Clk.

S. D. Rapid City—Plans under way for 12 blocks aditional paving. Mr. Spitzer, City Engr., Rapid City. J. P. Egan, City Auditor.

S. D., Sturgis—State Highway Commission will call for bids this summer for FAP 140, Meade and Lawrence Cos. Excav.: 57,000 c. y.; culverts: 1,060 lin. ft. pipe; Conc.: 350 c. y.; Reinf. steel: 35,000 lbs.; Guard rail: 2,600 lin. ft.; Viaducts: 3 conc.—length 7.06 miles. Est. cost $85,049. Jas. G. Wilson, Co. Aud.

Tex., Beaumont—Geo. J. Roark, City Manager, plans shell paving 50 blocks.

Tex., Canton—Van Zandt Co.—F. W. Gaines, Co. Engr.—contemplates 9.5 miles North loop of S. H. 15. Est. cost $80,000. C. L. Hubbard, Co. Judge.

Tex., Crockett—Chf. Engr., U. S. Bureau Pub. Rds., Washington, has approved plans for 6.9 miles gravel surfaced rd. on S. H. 12, Houston Co. Est. cost $124,085. C. H. Milburn, Co. Engr.

Tex., Falfurrias—Brooks County plans to surface 10 mi. S. H. 12, bet. Falfurrias and Hidalgo Co. line; gravel caliche. $90,000 Fed. Aid granted. J. A. Brooks, Co. Judge.

Tex., Ft. Worth—Bureau of Public Roads has approved 3 road projects as follows: Schleicher Co. 9.9 mi. road from 2 miles so. of Tom Green Co. line on Sonora-San Angelo Rd.; gravel with bitum. top; $133,859; fed. aid $30,466; Red River Co., 7.6 mi. gravel rd. on S. H. No. 6 from Bagwell to Lamar Co. line thru Detroit; $102,047; Fed. Aid, $32,846; Palo Pinto Co., 9.8 mi. rd. from Stephens Co. line to Metcalf Gap, waterbound macadam with surf. treat., $201,181, fed. aid $25,000.

Tex., Mount Pleasant—Titus Co.—D. M. Cook, Co. Judge—plans to improve 4.17 miles Pittsburgh-Carson Hwy. from Morris County line to Camp Co. line. Est. cost $60,000. H. S. Wilder, Co. Engr.

Tex., Palo Pinto—Palo Pinto Co.—E. L. Pitts, Co. Judge—will receive bids soon to surface 9.8 miles no. branch S. H. No. 1; bitum. macadam, $200,000. G. W. Courter, Co. Engr.

Utah, Salt Lake City—State Rd. Dept. will take bids in spring for grading and gravel surfacing 19 miles rd. from Chicken Creek to Millard Co. line, 18 ft. Juab Co., $120,000. H. C. Means, State Rd. Engr.

Va., Chalottesville—Albemarle Co. Bd. of Supvrs. will receive bids for 2 sections of roads as follows: 1½ miles bitum. macadam rd. bet. Gills Store and Jarman's Gap on Blair's Park Rd.; bet. Ortman's and William's Park, on Jordan Rd. Total cost, $30,000.

Va., Norfolk—Chas. M. Ashburner, City Mgr., plans expending $56,013 to pave 21st St.—Colley Ave. to W. Ghent Blvd.

Wash., Colville—Work will soon start on Inland Empire Hwy. betw. Colville and Meyers Falls, a little over 9 mi. Legislature apportioned $95,000 for the work. Right-of-way has been secured.

Wash., Seattle—King County Engr. Thos. R. Seaman reports that next county rd. proj. for which bids will be asked, is the Maury Island proj. calling for beach road trestle bet. Dockton and Melita. Approx. cost $70,000. Plans covering White Center South paving proj. now being checked by State Hwy. Dept., at Olympia, and bids will be called in abt. 6 weeks on the paving of something over a mile of 16th Ave.—White Ctr., so. toward Lake Burien. Est. cost, not including grading, $25,000.

Wash., Yakima—In case legislature carries out his recommendation, Jas. Allen, State Hwy. Commr., will have available about $440,000, in addition to sum reappropriated by state legislature for completion of grading of Ellensburg-Yakima canyon rd. Commr. Allen plans to spend abt. $100,000 for surfacing canyon rd., linking Yakima and Ellensburg. Other proposed rd. expenditures include paving approaches to new Nelson brdg., now being built by County. $200,000 will be spent on paving Buena-Dalton hwy. Straightening rd. bet. Union Gap and Parker, eliminating 3 dangerous grade crossings, is projected, as well as several other lesser highway jobs.

W. Va., Fairmont—Marion County, Winfield Dist., plans to build Morgantown Pike bet. Fairmont and Morgantown thru Dist. $200,000 bonds voted. F. J. Wilfsong, Co. Rd. Engr.

Wis., Marshfield—Town considering 175,000 sq. yds. paving. J. H. A. Brahtz, 509 Metropolitan Opera Bldg., St. Paul, Engr. J. Seubert, City Clk.

Wis., Oconomowoc—Prelim. plans being made for paving following: N. Main, Hickory and 2nd Sts., 10,000 sq. yds. vit. brk. asph. conc. or one course conc., 8,000 lin. ft. conc. gutter. $25,000. J. A. Stemper, City Hall, Engr. T. S. Johnson, City Clk.

SEWERAGE AND SEWAGE TREATMENT.

Ark., Mena—City contemplates voting on $40,000 bond issue for purchase of sewer system, bldg. extensions on main, together with disp. sys. at outlet.

Cal., Los Angeles—City Council has authorized the employment of four assistant engineers and 24 draftsmen to prepare plans for proposed Main and Moneta storm drain systems to take care of flood waters in southern section of city.

Cal., Pasadena—City Engineer, W. C. Earle, announces plans under way for laying more than 20 miles sewer pipe in northwest section of City and in Linda Vista during summer. Outfall, which will reach to Brookside Park, will be 23-in. diam. pipe. Plans being prepared but no estimate has been made.

Ont., Niagara Falls—Stamford Twp. considering laying vit. tile san. sewers in Stanley, 7th, Ash, Culp and Victoria Sts. 8-in. and up. Est. cost $200,000. M. Kerr, Twp. Hall, Engr.

B. C., Nelson—Plans being prepared and will take bids in abt. 2 months for sewers in Fairview Dist. Est. cost, $56,000.

Ont., Toronto—City plans 15,000 ft. relief sewers in Macdonnell, Cowan, Starr and Spencer Aves., Queen St., W. King St., W. and Dominion St. Est. cost $373,000. R. C. Harris, City Engr.

Kans., Frontenac—A. T. Archer & Co. Engrs., 609 New England Bldg., Kansas City, Mo., will soon take bids for san. sewerage system. $50,000-$75,000.

Ill., Kankakee—Soldier Creek D. D. plans 8,600 ft. conc. monolithic and segmental block sewers. $350,000. R. Gregg, City Engr.

Ill., No. Brooke—City plans to construct san. and storm sewers. Est. cost $130,000. Consoer Engrg. Co., 140 S. Dearborn St., Chicago, Cons. Engrs.

Md., Baltimore—City considering extension of san. sewer sys., in Frederick, Rd. and Gwynn Falls section. Milton J. Ruark, Div. Engr. Sewerage Div.

Mich., Lansing—Alvord, Burdick & Howson, 8 S. Dearborn St., Chicago, Ill., Cons. Engrs., for water softening plant proposed to be constructed here at cost of $700,000.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son, The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Neb., Omaha—City will soon take bids for constr. of storm sewers in various streets. Approx. cost $875,000. H. Beal, City Engr.

N. D., Fargo—Plans under way for system (water and sewer) in Northside Addn. To be independent unit. Will start work in near future. Robt. T. Jacobson, Fargo, City Engr. R. R. Watkins, City Clk. Est. cost $75,000.

Ohio, Cleveland—City considering constr. of sewage disp. plant in E. 71st St., Cuyahoga Heights Village. Est. cost $3,000,000. R. Hoffman, City Hall., Engr.

Ohio, Columbus—Prelim. plans for sewer from above Ohio State University along Olentangy River down thru City being made. Est. cost $200,000. R. E. Simpson, City Engr.; J. H. Gregory, Cons. Engr.

Ohio, Warren—City contemplates bldg. storm water sewer in Northwest section. Est. cost $98,000. Engineer not announced.

Pa., Grove City—$50,000 bonds voted here for sewage disposal plant. Engineer not yet announced.

Pa., Oil City—City considering constr. of sewer for Oil Crk. Est. cost $75,000. J. Webber, City Engr.

S. C., Greenville—$100,000 available for sewer impvts. W. D. Neves, City Engr.

Tex., Ft. Worth—City will soon ask bids for constr. of Henderson Street storm sewer betw. North and Texas Sts. Will also construct sewer on so. side East and West Rosedale Sts. and De Zavala St. $800,000 available.

Utah, Ogden—City Commissioners will take bids early in spring for 8, 12-in. vit. san. sewers in Dist. No. 147, $50,000; 8, 14-in. vit. pipe in Dist. 149, $50,000. W. S. Graven, City Engr.

Wash., Pullman—City plans to co-operate with state to continue sewer about a mile further, and construct new septic tank and disposal beds at cost of at least $50,000, bonding city for its share.

Wis., New Holstein—Prelim. plans under way for sewer and water systems. Est. cost $125,000. J. Donohue & Co., Acker Bldg., Sheboygan, Engrs.

Wis., Cashton—Plans made for sewerage and sewage disp. plants. West Plant: 1,340 ft. 6-in, 13,189 ft. 8-in., 1,268 ft. 10-in. pipe; 64 manholes; est. cost $18,529, sewage disp. plant, $10,836; East Plant, 1,244 ft. 6-in., 2,997 ft. 8-in., 200 ft. 10-in.; 22 manholes, 1,407 ft. 10-in. wd. stave pipe. Est. cost $7,569. Disp. plant, $6,265. W. G. Kirchoffer, Madison, Engr. P. J. Hegge, City Clk.

WATER SUPPLY AND PURIFICATION.

Ala., Talladega—$239,000 bonds sold and City will ask bids in near future on constr. work.

Ark., Booneville—Plans revised for constr. of water distribution sys. in Water Wks. Dist. 1; also new san. sewerage system in Sewer Dist. 1. Est. cost, $90,000. W. L. Winters, 312 Merchants National Bank Bldg., Ft. Smith, Engr.

Ariz., Tucson—City Engineer G. H. Atchley, and R. D. Whitacre, City Water Supt., have reported to City Council on proposed cost of extensions and betterments to City Water distributing system. Est. cost, $700,000. Work involves, among other items, about 55 miles of cast iron pipe of various sizes.

Cal., Manhattan Beach—Standard Oil Co. has purchased 280 acres for storage farm. Plans started for 4 reservoirs, each to hold 2,000,000 gals. They will be of cement construction with wooden rfs.

Cal., Sacramento—City considering construction of big hydro-electric project by which it is proposed to develop 140,000 h.p. and incidentally furnish a water supply of 300,000,000 gals. daily. City appropriated $15,000 last yr. to investigate scheme and report justifies issuance of statement recommending organization of public utility district for purpose of constructing the works, including acquisition of existing distribution systems in City. Initial constr., which will provide 40,000 h.p. of energy, will cost $4,000,000 and the distributing system an additional $4,000,000. Site is located on one of the tributaries of the American River, abt. 72 mi. from City. Watershed embraces nearly 200 sq. miles and reservoir capy. can be developed to abt. 250,000 acre feet.

Cal., Santa Barbara—$850,000 bonds carried at special elec. Mch. 1. Funds will be used for water supply and distributing sys. for Montecito Co. Water Dist. Plan is to construct tunnel thru Toro Canyon at cost of $350,000 to secure a seepage flow, sufficient for present needs; also to build distributing sys. costing $500,000. Cook, Wyant & Moore, Cons. Engrs., prepared prelim. report for Dist.

Cal., Santa Fe Springs—Union Oil Company has completed surveys for 750,000-bbl. cement reservoir to be built at Santa Fe Springs field. Work will start immediately under direction of Geary Neal, Res. Engr.

Fla., Gainesville—City considering voting on $300,000 bonds for extension and impvt. to sewer, water and light facilities; also paving.

Fla., Tampa—$2,650,000 bonds voted by City for purpose of purchasing properties of Tampa Water Wks. Co., and to make extensions to system.

Md., Williamsport—Burgess & Commrs., will construct water sys., of 150,000 gals. daily capy., install pumps, etc. $100,000 bond issue authorized. Norton, Bird & Whitman, 615 Munsey Bldg., Baltimore, Engrs.

Mass., Boston—State Dept. of Health, in report, recommended that Lowell, Lawrence, Methuen and Dracut join in a scheme for supplying all from a common water supply.

Mich., Lansing—City contemplates bldg. water-softening plant. Est. cost $700,000. Alvord, Burdick & Howson, 8 S. Dearborn St., Chicago, Cons. Engrs.

Minn., St. Paul—J. W. Kelsey, Supt. of Water Works, advocates $2,000,000 bond issue for extension of water works system.

Minn., Owatonna—City will improve water works; 500,000 gal. storage tank, increase pumping capy. Cons. Engr. J. H. A. Brahtz, 508 Metropolitan Opera Bldg., St. Paul. C. J. Servatins, City Clk.

Miss., Belzoni—Election in April to vote on $125,000 bonds for rebldg. water and light plant; also paving sts.

Mo., Kirksville—City will expend $260,000 on water works extens. daily capy. 1,000,000 gals.; will install one extra pump unit of 600 gals. capy. Black and Veatch, Engrs., Kans. City, Mo. Will vote April 17th on $260,000 bonds.

N. Y., Ballston Spa—Bd. Village Trustees and Chamber of Commerce plans new water supply from Crook Brook. Est. cost $100,000. J. L. Tracy, Vil. Pres.

N. Y., Beacon—Taxpayers will be requested to approve appropriation of $190,000 for purpose of bldg. new dam at Melzingah and to equip filter plant to purify water supply.

N. C., Fayetteville—Bd. of Aldermen will issue $350,000 bonds for water and sewerage extension.

N. C., Lexington—City plans to issue $125,000 water bonds; $75,000 sidewalk, curb and gutter bonds, and $25,000 sewer bonds.

Okla., Nowata—Board of Commrs. appointed Benham Engineering Co., Cons. Engrs., Kans. City, Mo. and Okla. City, Okla. for engrg. work in connection with water works impvts., consisting of rebldg. pumping sta., modern rapid sand mechanical filtr. plant, water main extensions and storage reservoir. Will probably vote on bond issue.

Okla., Wynnewood—Bonds amounting to $85,000 voted for extensions to water works plant and electrical system.

Pa., Philadelphia—City Commission authorized expenditure of $129,533 for additions and impvts. to water supply system.

Tenn., Lewisburg—City contemplates constr. of reservoir and installation of filtration plant; will probably vote on $130,000 bonds.

Tex., Dallas—City will vote in April on $8,325,000 bonds for various impvts. Included is $5,000,000 for water supply; $500,000 for sewage disposal and $150,000 for sanitary sewers.

Tex., Perryton—City will expend $110,000 for extension of present plant and construction of new; 300 h.p. install 150-h.p. oil engine, $14,000; 75,000 gals. capy. tank, $7,000; cost of bldg., $6,000. Gant-Baker, Cons. Engr., Okla. City, Okla.

W. Va., Keyser—City will expend about $175,000 for impvts. to water works system; will relay and enlarge water mains, cost $40,000. Est. cost of filtration plant equipped, abt. $90,000; mech. filtration plant with low or high pressure pumps, stand-pipe, 50x60 ft. high. Est. cost, $15,000.

BUYERS' GUIDE

Pumps.
De Laval Steam Turbine Co.
Evinrude Motor Co.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Structural Steel.
Lewis-Hall Iron Works.

Subgrading Machines
Austin Machinery Corp.
The Hug Co.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
The Barrett Co.

Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Nutting Co., H. C.
Van Trump, Isaac.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Traffic Signals.
Electrical & Specialty Supply Co.
Little Giant Co.

Trailers.
Lee Trailer and Body Co.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
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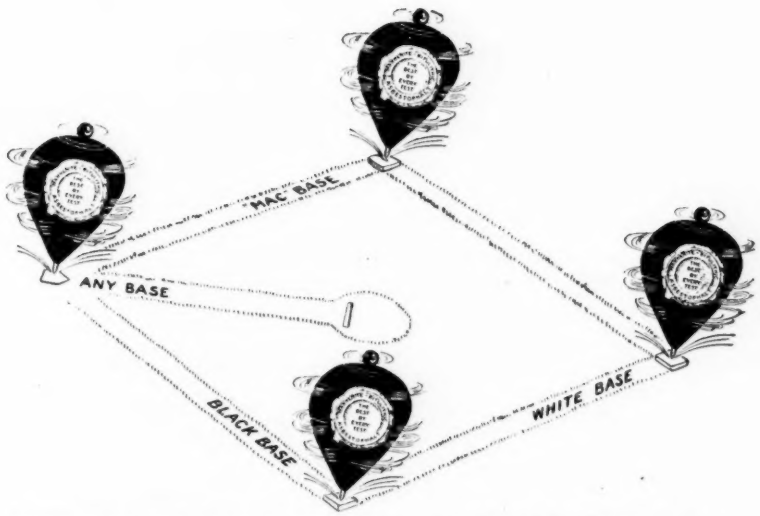

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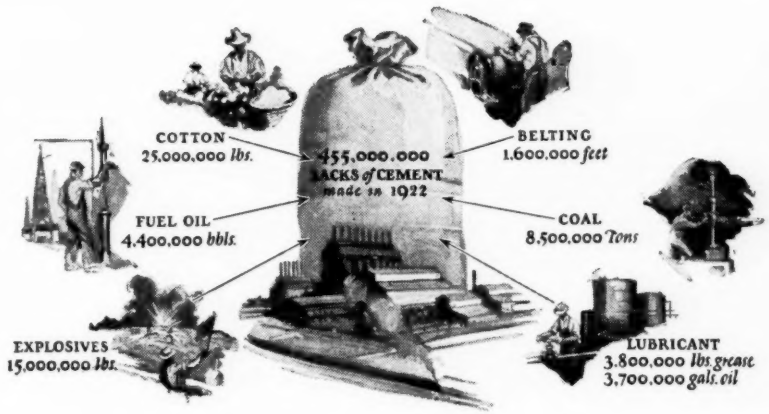

Your Business—*and* Cement

WHO OPERATES a basic industry is less important than how many people benefit by it.

From the cement industry, an extraordinary number benefit.

In making the 455,000,000 sacks turned out last year, the mills used 8,500,000 tons of coal. This meant 8,500 coal miners steadily employed—their families, numbering not less than 25,000, maintained—and along with them tradesmen and other people enough to supply the needs of a town of over 50,000.

That is, of course, saying nothing of the business created for coal operators and transportation lines.

Sacks are a lesser item in the cement industry than coal, yet 50,000,000 new sacks, representing 50,000 bales—25,000,000 pounds—of cotton, had to be bought last year. Back of this were cotton planters, plantation workers, mill owners, mill operatives and so on—thousands altogether.

And consider these other requirements of the industry last year:

4,400,000 barrels of fuel oil
3,400,000,000 cubic feet of gas
15,000,000 pounds of explosives
32,600,000 pounds of greases and oils
1,600,000 linear feet of belting
4,500,000 firebrick for relining kilns
7,000,000 pounds of paper for bags
570,000 tons of gypsum

In addition the industry bought quantities of heavy grinding and burning machinery, locomotives, cars, rails, electrical and other necessary equipment.

It's interesting, isn't it, how a single industry can spread prosperity?

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A National Organization to Improve and Extend the Uses of Concrete

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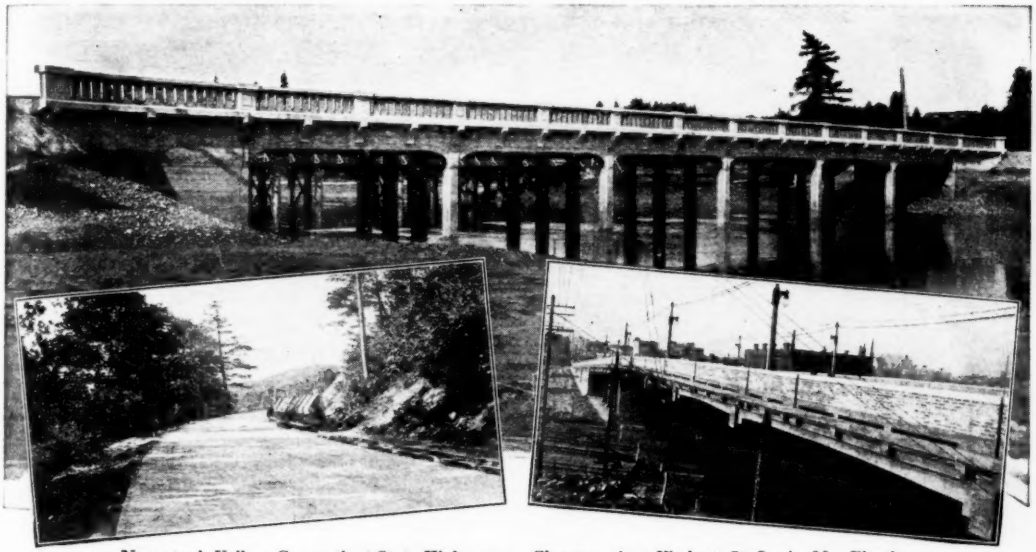

Naugatuck Valley, Connecticut State Highway. Elastite Expansion Joint concealed

Chouteau Ave. Viaduct, St. Louis, Mo. Elastite Expansion Joint used

Above — Mud Bay Bridge, Olympic Highway, Thurston County, Wash., Frank Weir, County Engineer, Union Bridge Co., Seattle, Builders. Elastite Expansion Joint used

To absorb expansion stresses in any concrete structure use Carey Elastite Expansion Joint

YEARS of successful experience have proved the efficiency of Elastite Expansion Joint in practically every type of concrete construction. It is accepted by engineers and contractors as a standard joint material that has long since passed the experimental stage, functioning effectively under all climatic conditions. It is easily installed at minimum labor cost and without waste, breakage, or joint-repairing.

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Elastite Expansion Joint at below-zero temperatures is plastic and elastic. Elastite Expansion Joint retains plasticity in any temperature. It does not melt. It does not shatter.

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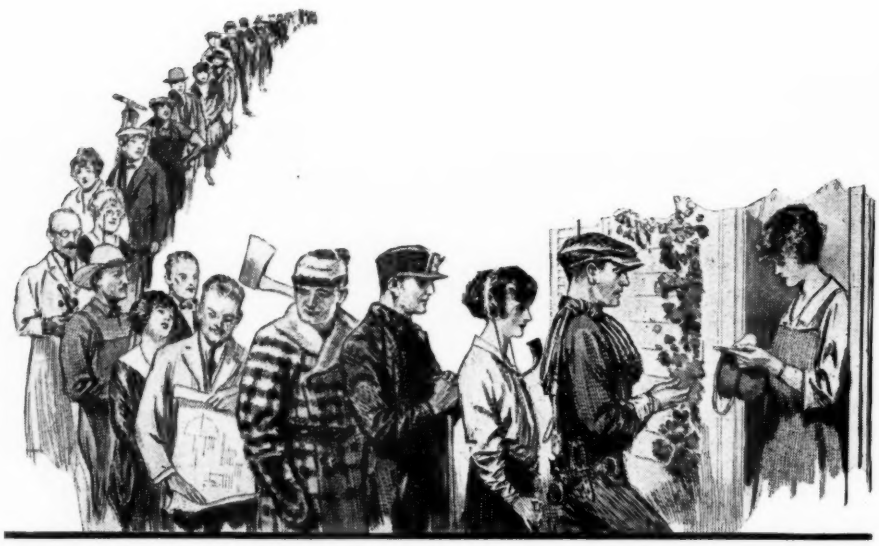

If the subscriber paid direct

Suppose that every Monday morning all the people who have a hand in furnishing your telephone service came to your door for your share of their pay. From the telephone company itself, would come operators, supervisors, chief operators, wire chiefs, linemen, repairmen, inspectors, installers, cable splicers, test-boardmen, draftsmen, engineers, scientists, executives, bookkeepers, commercial representatives, stenographers, clerks, conduit men and many others, who daily serve your telephone requirements, unseen by you.

There would be tax collectors to take your share of national, state and municipal taxes, amounting to over forty million dollars. There would be men and women coming for a fair return on their money invested in telephone stocks and bonds—money which has made the service possible.

Then there are the people who produce the raw materials, the supplies and manufactured articles required for telephone service. They would include hundreds of thousands of workers in mines, smelters, steel mills, lumber camps, farms, wire mills, foundries, machine shops, rubber works, paint factories, cotton, silk and paper mills, rope works, glass works, tool works, and scores of other industries.

When you pay your telephone bill, the money is distributed by the company to the long line of people who have furnished something necessary for your service. The Bell System spares no effort to make your service the best and cheapest in the world, and every dollar it receives is utilized to that end.

"BELL SYSTEM"

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

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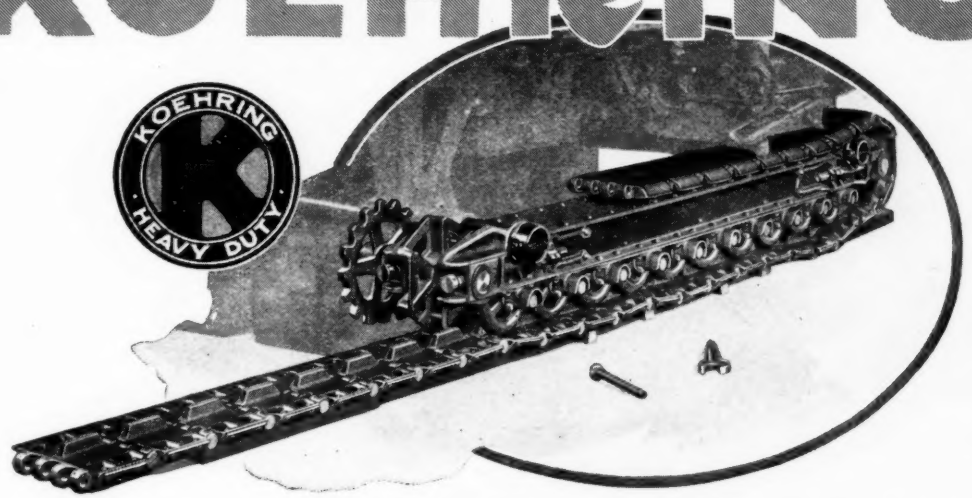


Multiplane Traction with Three Point Suspension

THIS is another Koehring "HEAVY DUTY" feature not common to this type of traction.

Three point suspension which is accepted as indispensable to good mechanical mixer construction is retained with Koehring multiplane traction. Nothing but three point suspension can protect mixer frame from terriffic strains.

Liberal width planes give lowest ground pressure per square inch.

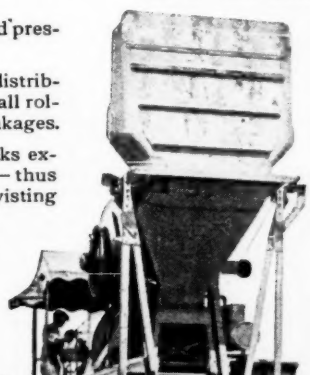
Rollers mounted rigidly in one unit, distribute strain of climbing an obstacle over all rollers—a construction that forestalls breakages.

Shoes are fastened together by four links extending the full width of each shoe—thus Koehring construction overcomes the twisting strains that are the cause of breakage.

The remarkable accessibility of the Koehring multiplane is a special Koehring feature. Pins are easily removable.

Mixer can be jacked up and entire multiplane unit can be easily removed.

The Koehring multiplane is a measurable improvement in this type of traction—in serviceability, stand-up ability and accessibility. Koehring "HEAVY DUTY" construction means no short cuts in construction, no slighting of the wide safety margin essential to dependability and service life.



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Construction Mixers: 10, 14, 21, 28 cu. ft. mixed concrete. Write for Catalog C.**10**

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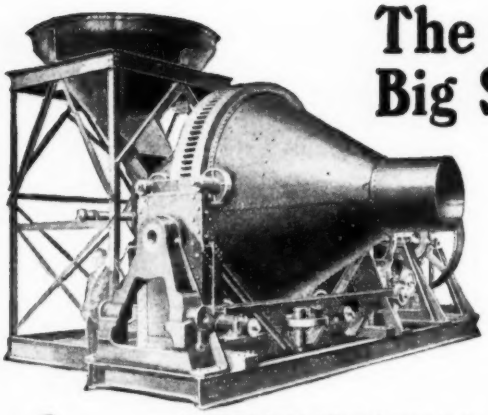
The Little Brother of the Big Smith Tilting Mixers

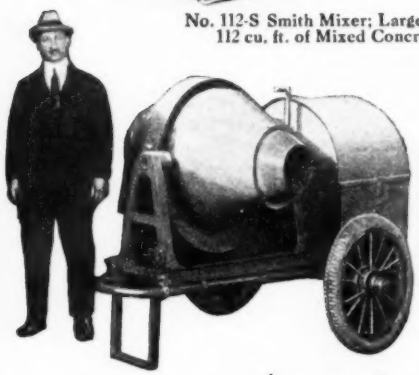


No. 112-S Smith Mixer; Largest in the World—112 cu. ft. of Mixed Concrete per Batch.

Now and again, some new invention or development is brought out which, because of its importance, causes an unusual amount of comment. Now comes the new Smith 375, a Half-Bag Tilting Mixer, which is just such an invention. The mixed batch capacity is 3¾ cu. ft., which is a full half bag (1–3–6 mix) with materials containing the usual 40% voids.

The Fame of Smith Tilting Mixers

This little mixer is the same famous Smith Tilting Mixer which has been the quality standard of the mixer industry for twenty-three years—the same duocone tilting drum, same central gear-ring and roller track, same independent tilting frame, same tilting discharge. It's the same Smith Tilting Mixer that mixed the concrete for the Miami Conservancy District, General Motors Office Building, Fisher Body Plant, U. S. Government Dam at Muscle Shoals, New York Aqueduct and dozens of other world famous projects. It's the same general design and quality as the largest mixer in the world shown above.



Smith 375 Half-Bag Tilting Mixer—Two-Wheel Model R W-1—Pressed Steel Wheels Fitted with Clincher Rims for Ford 30 x 3½ Pneumatic Tires.

A Mixer of Highest Quality

In spite of its small size and low price the Smith 375 is the best-made machine in the entire Smith line. The inspection is most rigid and the parts are all made to the closest micrometer tolerances of any machine we build.

Smith 375 Half-Bag Tilting Mixer with Feed Chute—Four-Wheel Model S W-1—Discharge Side—Tilting Lever Locks in Discharge Position. Drum returns Automatically when lever is released.

Real Portability at Last

Light weight (1100 pounds) plus real speed trailer trucks—the last word in a portable machine. Two steel bronze-bushed wheels equipped for Ford tires, with an extension hauling stub and a pivoted front supporting stub. Hitch it on behind your Ford and you are ready to go.

Smith 375 Half-Bag Tilting Mixer—Four-Wheel Model SW-1—Charging Side with Feed Chute and Low Charging Platform.

Quantity Production—Lowers Price

Price was hardly considered; Smith Mixer quality, speed and durability were the prime considerations. But large quantity production, combined with Smith manufacturing facilities and Smith invention and design have made possible a low price which makes the Smith No. 375 the biggest mixer value ever offered to the trade.

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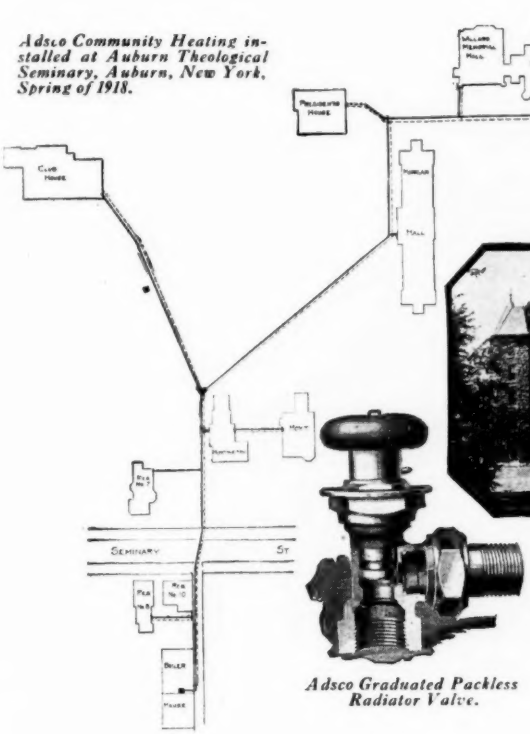
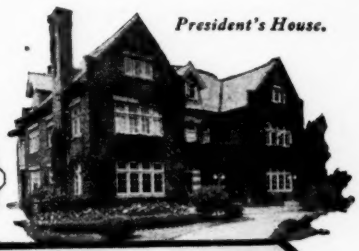
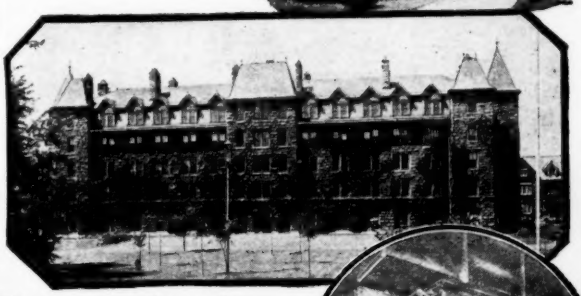
SMITH **MIXERS**

Adsco Community Heating installed at Auburn Theological Seminary, Auburn, New York, Spring of 1918.



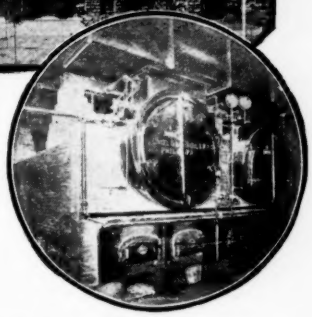
President's House.





Morgan Hall.

Interior Central Heating Station.



Adsco Graduated Packless Radiator Valve.

Auburn Theological Seminary Enjoys Adsco Community Heating

For many years Auburn Theological Seminary had been heating its eleven buildings with individual systems. This meant fire hazard in each building, waste of fuel, and unnecessary expense of operation.

Dr. Stewart, President, realizing the discomfort and expense of such antiquated heating methods invited our engineers to suggest the most modern way to take care of this heating problem. The result was our design and installation, in the spring of 1918, of 1447 feet of underground mains, distributing steam from a central station plant with not only the economy of one boiler in place of eleven heating systems, but also the comfort of more even temperatures better controlled in each of the eleven buildings.

Those in control of similar groups of buildings are invited to follow Dr. Stewart's example and avail themselves of our forty-six years' engineering and contracting experience in Community Heating.

Write for our interesting Booklet on Adsco Community Heating, Bulletin No. 20-ME. For individual buildings, ask for Bulletin No. 158-ME, on Adsco Heating for use with any type of boiler.

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Chausse Oil Burning Tool Heater

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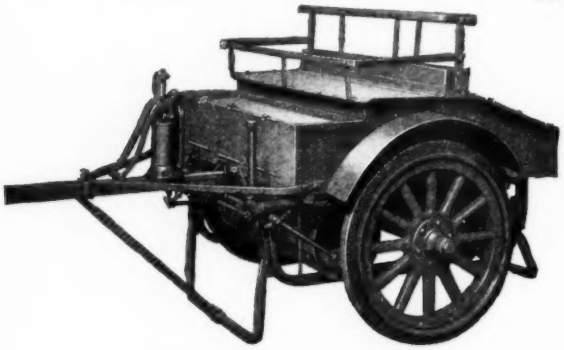

There is no smoke, no sparks, no ashes, no fuel to collect and haul. It is not affected by rain or wind, burns kerosene or distillate. Carries sufficient fuel for sixteen hours burning at maximum heat. Has solid rubber tires and Timken bearings. Can be pushed by one man or hauled noiselessly at any speed.

Used successfully in Chicago, Detroit, Milwaukee, and other cities.

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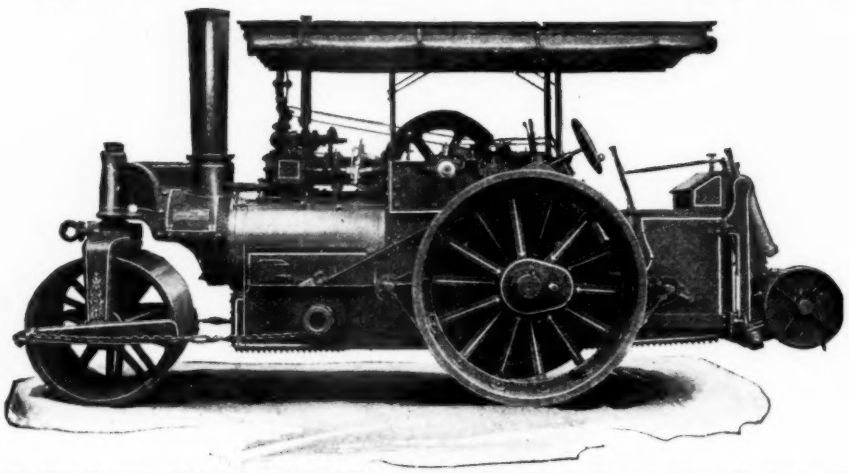
Chausse Oil Burner Company

206 Lincoln Building **Detroit, Michigan**

QUALITY ROLLERS



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* * * *

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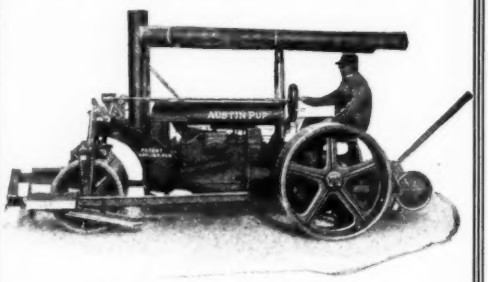

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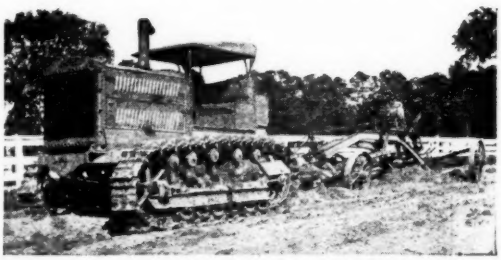

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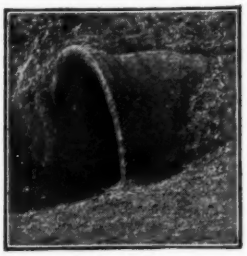

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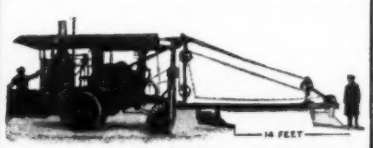

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